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AUGUST 1920 No. 210

United States Naval Institute

Proceedings

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CONTENTS

	PAGE
Accuracy of Fire at Long Ranges.—Chase	1175
Tact in Relation to Discipline.—Hoffman	1197
Sketch of Present Radio Situation Influence on Tactics and Strategy.—Hooper	1209
The "St. Lawrence" and the "Petrel."—Morgan	1219
An Application of the Method of Analyzing the Engineering Performance of Destroyers.—Osgood	1223
Our First National Shipping Policy.—Baxter	1251
Report and Recommendations of a Board Appointed by the Bureau of Navigation Regarding the Instruction and Training of Line Officers	1265
Secretary's Notes	1293
Professional Notes	1295
Notes on International Affairs	1289
Review of Books	1281
Information Index	1294

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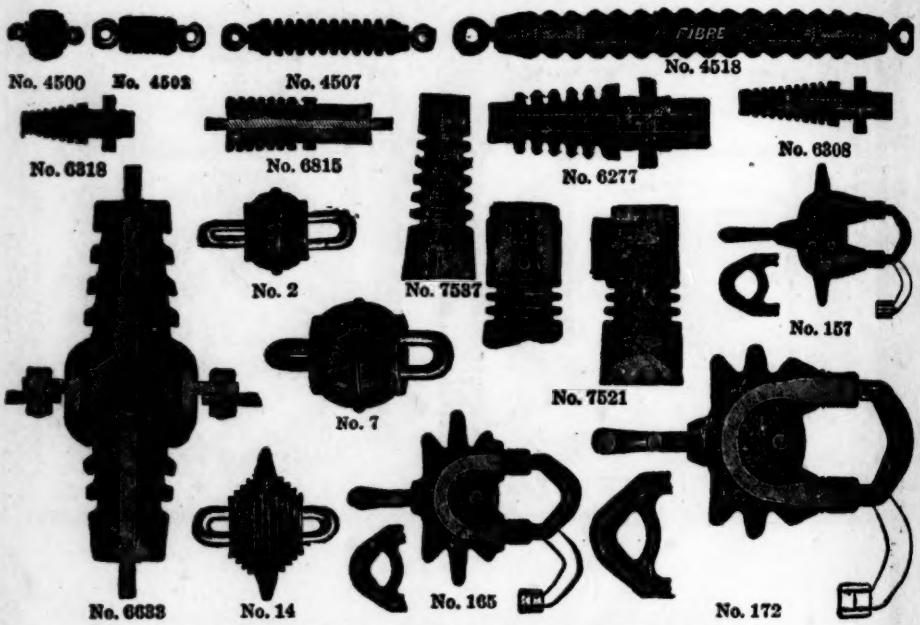

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Vol. 46, No. 8 August. 1920 Whole No. 210

United States Naval Institute

Proceedings

PUBLISHED MONTHLY
EDITED BY H. K. HEWITT

U. S. NAVAL INSTITUTE
ANNAPOLIS — MARYLAND

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By J. W. CONROY
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The Lord Baltimore Press
BALTIMORE, MD., U. S. A.

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UNITED STATES NAVAL INSTITUTE PROCEEDINGS

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ACCURACY OF FIRE AT LONG RANGES

By CAPTAIN J. V. CHASE, U. S. Navy

In recent years there has been much discussion on the subject of the accuracy of our naval guns at long ranges, brought about not only by the natural increase in practicable ranges, due to the development of guns of larger caliber and greater velocity, but also to the laudable desire to push the effective battle range to the extreme limit possible.

Undoubtedly greater accuracy of weapons and superior skill of personnel have their most telling effects at long ranges, for at these ranges superior accuracy and skill affect most decidedly the relative number of hits obtained.

Some 17 years ago, I undertook a mathematical investigation to ascertain the value of the advantage accruing to a naval force engaging an adversary numerically equal but so placed that a portion of his force was masked or beyond effective range. The result of this investigation showed that the advantage was measured, not by the ratio of the number of the opposing ships actually engaged, but by the square of this ratio. Here was the first statement of the so-called "n square law," a law discovered independently some years later by an English writer.

The application of this law to long range fighting is this: Suppose our greater accuracy of weapons and superior skill makes us feel confident that at a certain long range we can

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make 4 hits to our adversary's 3. Then if we engage a numerically equal force at that range our superior hitting ability makes this numerically equal force equivalent to one only $\frac{3}{4}$ as large possessing, ship for ship, a hitting power equal to our own. Therefore, according to the n square law our chances of victory are not as 4 is to 3, but as 16 is to 9. Moreover this law shows that in this case the superior force after annihilating the inferior would have left the equivalent of $\sqrt{\frac{7}{16}}$ of its original force.

The n square law is based upon the material damage inflicted and sustained and does not take into account the moral effect due to the knowledge of the inequality between the damage inflicted and that sustained, a knowledge giving rise to a depression on one side and to a corresponding elation on the other.

Courage and grim determination may serve to minimize this moral effect, but in the inanimate vessels themselves is found no counterbalancing force to offset the physical advantages conferred by superior accuracy of weapons coupled with greater skill of personnel.

The foregoing brief discussion suffices to indicate the importance of attaining the maximum effective battle range. It may be well, here, to determine generally what may logically be called the maximum effective battle range. At short ranges the target presented by an adversary is wholly a vertical one and, in estimating the accuracy of our weapons, we are wholly concerned with vertical and lateral errors. As we increase the range we reach a point where the tangent of the angle of fall is approximately equal to the enemy's freeboard divided by his beam. At this point the target may be regarded either as a vertical or horizontal one. Beyond this point, the target is largely a horizontal one and we are concerned with range and lateral errors only in estimating the accuracy of our weapons. These errors increase as some function of the range, whereas the dimensions of the target remain fixed. It is obvious that with a given accuracy of weapons and skill of personnel a range may be established beyond which the probable number of hits obtainable by the expenditure of a ship's allowance of ammunition is insufficient to inflict serious damage upon an adversary.

The range so determined may be regarded as the extreme effective battle range. The accepted maximum effective battle range should be as little inside this extreme range as our judg-

ment indicates to be reasonable. As we cannot always count upon a full allowance of ammunition being on board we might define the maximum effective battle range as that at which the expenditure of 75 per cent of the ammunition allowance will probably produce a number of hits sufficient to cause serious damage to our adversary.

Nothing has been said, so far, regarding rapidity of fire. The time element, of course, must enter into our calculations, but a rapidity of fire purchased at the sacrifice of accuracy of fire is undoubtedly a disadvantage and not an advantage. If we fight at a maximum effective battle range justified by our superior accuracy of fire, maintaining a rapidity of fire consistent with such superior accuracy, it is obvious that a superior rapidity of fire on the part of our adversary avails him nothing. It simply hastens his useless expenditure of ammunition. We must strive to shorten the time between hits without increasing the number of misses. The longer the time between misses the better; it lessens the waste of ammunition.

It is difficult to foresee what will be the ultimate limit of the maximum effective battle-range as defined in the foregoing paragraphs. Before the development of aircraft there appeared to be a limit established by the limit of vision from the most elevated observation position practicable on the firing ship. The possibility of using aircraft for observation seems to indicate that the ultimate limit of the maximum battle range will be established solely by the ultimate accuracy of the weapons employed.

It behooves us, therefore, to increase this accuracy by every practicable means available.

The problem of hitting a target, stated in its simplest form, is (1) to determine what position the target will occupy at a given instant and (2) to direct our guns in such a manner that their projectiles will fall upon that spot at the given instant.

The two parts are largely independent, but closely coordinated. The first part is essentially the fire control problem, the second part is chiefly a matter of ordnance and gunnery and demands accuracy of weapons and their accessories. It is needless to remark that skill of personnel is demanded in both parts.

In the solution of the fire control problem there must appear some form of tracking. Some perfom this tracking by means of rangefinder distances, and bearings; others measure the dis-

tance by means of the guns themselves for, in reality, that is what we do when we attempt to "spot on." No matter which method or combination or variation of methods we adopt we must have confidence in our "yard stick." Rangefinder and gun alike must give readings on a fixed range differing little from the mean of all the readings taken by the same instrument; in other words, the mean error must be small. The French have a rangefinder mount carrying three rangefinders of the same size and type, and presumably having the same mean error and by an ingenious device utilize a continuous mean of the readings of the three instruments.

If D be the mean error of each instrument the mean error of the mean of their three readings is $D_0 = \frac{D}{\sqrt{3}} = .57735D$. In this way they get the same accuracy that could be obtained from a single instrument having a mean error equal to 57.735 per cent of the mean error of each one of the three instruments actually employed. The same principle can be applied to the gun when it is used as a rangefinder. By firing a 3-gun salvo, instead of a single gun for ranging shots, there would be obtained a mean range corresponding in accuracy to that obtainable by a gun having a mean error 57.735 per cent of that of each gun used, provided we could estimate accurately the position of the mean point of impact of the salvo.

No matter what method be employed we obtain, at certain instants, more or less accurate determinations of the enemy's position and from these positions a more or less accurate estimate of the enemy's course and speed. The more accurate the instruments employed, the more nearly correct will be our determination of the enemy's position, course and speed. It must be borne in mind, however, that however accurate these successive positions of the enemy may be, there will always remain the error due to the uncertainty of the enemy's movements during the interval of time from the last observation before our shots are fired until they land. In order to reduce this possible error to a minimum, we must cut this time interval down to the smallest possible. This means reducing as much as possible the time from the last observation to the firing of our shots and using the highest muzzle velocity practicable, so as to reduce the time of flight as much as possible.

Several articles have been written seeking to demonstrate that the mean errors of the gun should not be below a certain percentage of the fire control error in order to obtain the maximum percentage of hits. The arguments advanced appear reasonable, provided we regard the fire control error as being wholly independent of the gun error. The two errors are, however, closely related and it appears to me that so long as we use the gun in any way to measure the range we must have it as accurate as possible, and the two errors will approach the same value.

Let us consider the simplest case possible—a stationary ship firing at a fixed target whose distance is only approximately known. Suppose two ships fire 4-gun salvos—one with guns having a mean error of 100 yards and the other with guns having a mean error of 200 yards. Now the mean error of a salvo range—that is, the mean variation of the center of impact of a salvo from the true range—is in one case $\frac{100}{\sqrt{4}} = 50$ yards and in the other $\frac{200}{\sqrt{4}} = 100$ yards. This means that the chances are 9 to 1 that the salvo of one ship will not fall more than 100 yards from the point where it was predicted to fall. In the other case, the chances are the same that this distance will not exceed 200 yards.

Suppose in both cases the best estimate of the distance of the target is 18,000 yards and that the first salvo from each ship falls 600 yards short of the target. One ship feels reasonably certain that the true range of the target lies between 18,700 and 18,500. The other ship with the same degree of certainty knows the true range of the target lies between 18,800 and 18,400 yards. Let each ship increase the range 600 yards for the second salvo and let us consider the following cases: (1) the second salvo falls 200 yards short of the target; (2) 100 yards short; (3) at the target; (4) 100 yards over and (5) 200 yards over. Below are tabulated the limits of range as established by first salvo, by second salvo and both salvos:

An examination of the table shows clearly how reduction of the mean error of the gun reduces the fire control error. Moreover, a small mean error means generally well bunched salvos which facilitates the estimation of the distance of the center of impact to the target by observers in aircraft or captive balloons.

Even after the true range has been established and the fire is continued with a constant sight bar range, the centers of impact of salvos, at best, can be confined to an area whose center is the target and whose dimensions are directly proportional to the mean errors of the gun in range and deflection. It is obvious in this case that the salvos, whose centers of impact are confined to the smaller area, will score the greater number of hits.

Where target and firing ship are both moving the problem is more complicated but the same principles apply.

It is believed that the mean errors of rangefinders can be established for various ranges and then the rangefinders be used

Case	1st	2d	Both	1st	2d	Both
..	18,700 18,500	.....	.....	18,800 18,400	.....	.....
1	18,700 18,500	18,900 18,700	18,700	18,800 18,400	19,000 18,600	18,800 18,600
2	18,700 18,500	18,800 18,600	18,700 18,600	18,800 18,400	18,900 18,500	18,800 18,500
3	18,700 18,500	18,700 18,500	18,700 18,500	18,800 18,400	18,800 18,400	18,800 18,400
4	18,700 18,500	18,600 18,400	18,600 18,500	18,800 18,400	18,700 18,300	18,700 18,400
5	18,700 18,500	18,500 18,300	18,500	18,800 18,400	18,600 18,200	18,600 18,400

much the same as guns in measuring distances, the average of several simultaneous readings corresponding to a salvo of guns.

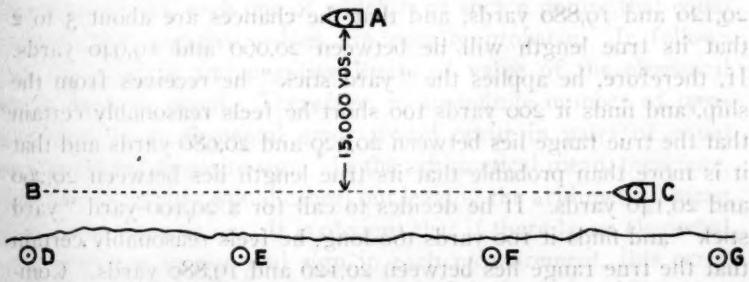
The sketch opposite shows a method of ascertaining the mean errors of rangefinders at various ranges.

It is evident that comparisons of the rangefinder readings with the true distances obtained from the plotting by the shore stations will give the rangefinder errors for the various ranges.

If a suitable place such as a strait can be found, where ships may pass on approximately opposite courses about 15,000 yards apart, and stations can be established on each side of the strait, then two vessels can steam on approximately opposite courses and take simultaneous rangefinder readings on each other. Each vessel's course will be plotted by its own set of stations and a

comparison of the two plottings will give the actual ranges at various times. Some form of trophy might be awarded to the vessel obtaining the most nearly correct set of ranges. In both of these tests, excellent practice in taking long varying ranges under way will be obtained and considerable knowledge of the working accuracy of the rangefinders will be accumulated.

Compared with the gun as a range measuring instrument, the present rangefinder has this disadvantage—its mean error increases at least as the square of the range, whereas that of the gun should increase approximately as the first power of the range. It would, therefore, appear that at some range their mean errors would be numerically equal—within this range the rangefinder



A=ship at anchor, position accurately plotted.
BC=course of ship taking simultaneously ranges on *A* at intervals.
D, E, F, G=accurately plotted shore station for fixing position of *A* and positions of ship steaming on course *BC*.

would be the most accurate range measuring instrument but beyond this range the gun would give the more accurate measurements.

It seems to me that as the maximum effective battle range is increased we must depend more and more upon the accuracy of our guns, not only to hit the enemy after we have established the true range but also to determine the true range. Our elevated observers, especially if we place them in aircraft are in a better position to utilize the range measuring ability of the gun than that of the rangefinder. Looking down upon the range, an observer can align his gun "yard stick" and estimate very accurately the amount it overlaps or falls short of the true range. One may regard the ship as a storehouse of a large number of such "yard sticks," each labelled with its supposed true length

but each varying from its tagged length by an amount not exceeding a known quantity depending upon the mean error of the gun. The observer calls for a certain length "yard stick," lays it down on the range and observes how much too short or too long it appears to be. He immediately knows the true range lies between certain limits, he calls for another "yard stick" and establishes new limits for his true range and by comparison with the first limits established narrows the limits between which the true range must lie. For example, suppose an observer is observing the fire of a ship firing 12-gun salvos, with guns having a mean error of 200 yards at 20,000 yards. The observer knows that if he calls for a 20,000 yard 12-gun salvo "yard stick" that the chances are over 9 to 1 that its true length will lie between 20,120 and 19,880 yards, and that the chances are about 3 to 2 that its true length will lie between 20,060 and 19,940 yards. If, therefore, he applies the "yard stick" he receives from the ship, and finds it 200 yards too short he feels reasonably certain that the true range lies between 20,320 and 20,080 yards and that it is more than probable that its true length lies between 20,260 and 20,140 yards. If he decides to call for a 20,100-yard "yard stick" and finds it 100 yards too long, he feels reasonably certain that the true range lies between 20,120 and 19,880 yards. Combined with the first results, this makes him feel reasonably certain that the true range lies between 20,120 and 20,080 yards. He can, therefore, call the true range 20,100 yards and feel reasonably certain that the range thus established is not more than 20 yards in error.

So far, I have dealt with that part of the problem of hitting a target that has to do with the accurate determination of the position of the target at a given instant, and have shown how important is the accuracy of our guns, regarded merely as rangefinding instruments. There remains that part of the problem which relates to placing our projectiles at the given instant on the position occupied by the target. It is needless to remark that in this part of the problem the accuracy of our guns is *all* important, for it is obvious that accurate determination of the position of the target and rapidity of fire avail us nothing if we be unable to place our projectiles where we desire them to fall.

Now human experience shows that the perfect instrument never has and probably never will be made. Even when we seek to

solve the simplest physical problem, such as ascertaining the true distance between two fixed points, we find that no matter how carefully and accurately made our measuring instruments may be, and no matter how carefully we use it under conditions that appear so far as we can judge, to be identical, we do not obtain identical values.

Experience has taught mankind to make a number of measurements under conditions which appear to be identical and to accept the arithmetical mean of these measurements as being the nearest approximation to the true value attainable with the instruments available. This faith in the arithmetical mean is based upon the assumption that the difference between any particular reading and the true value is made up of the algebraic sum of a number of elemental errors, each one of which is of such a nature that equal positive and negative values are equally probable. It follows that the positive and negative limits of value of the elemental errors must be equal. Therefore, in an infinite number of measurements each elemental error would occur in pairs of equal magnitude but opposite sign. In the arithmetical mean, therefore, all elemental errors would cancel out leaving the arithmetical mean equal to the true value. It is obvious that if there be an elemental error constant in size and sign in each measurement, this error will appear undiminished in the arithmetical mean. Moreover, if there be an elemental error whose positive and negative limits are unequal, the arithmetical mean will contain the mean value of this error no matter how great may be the number of measurements made.

Based upon the accuracy of the arithmetical mean and the nature of the elemental errors, as set forth above, mathematicians have evolved a theory of errors and deduced the " error function " which is a continuous function between the limits of $+\infty$ and $-\infty$ and, therefore, covers all errors between those limits.

Inasmuch as it is unlikely that in any given measurement, all or a great majority of the elemental errors will have the same sign, the conclusion is reached that small errors are more frequent than larger ones.

As has been said, the theory of errors cover all errors between $+\infty$ and $-\infty$ and so tacitly assumes that infinite errors in either direction are possible. Now, as a matter of fact, in practically all physical problems an infinite error in either direction is an

impossibility. This discrepancy between theory and practice, however, is easily reconciled as the probability of having an error greater than a certain moderate size is very small and in general can be neglected. Practically we do not consider the possibility of committing an error greater than 4 times the mean error. According to the theory of errors in every 2000 measurements we should expect to find 3 errors greater than 4 times the mean error.

Mankind has not been satisfied to accept the arithmetical mean as being the best value obtainable, but has sought some means of ascertaining how near the true value this mean really is. In the size of certain defined errors is found the best indication of the accuracy of the results obtained. These defined errors are (1) the probable error, (2) the mean absolute error, and (3) the mean error.

The probable error is that error which is just as likely to be exceeded as not. This error is the one generally adopted by scientists as the criterion of the accuracy of their measurements. The mean absolute error is thus defined—if we find the variation of each measurement from the true value and, considering only the absolute value of these variations (disregarding signs), obtain the mean value of these variations, this is the mean absolute error. For reasons to be explained later, this is the criterion generally adopted for ascertaining the accuracy of fire. Generally, the word "absolute" is omitted, as the *true* "mean error" is seldom employed and is only of academic interest. The *true* mean error is obtained by a process similar to that for obtaining the mean absolute error except that each variation is squared and the square root of the mean of the squared variations gives the value of the mean error.

All these errors may be expressed in terms of a quantity known as the measure of precision. If their values be obtained from an infinite number of measurements, such values are called observational values. If obtained from a finite number of measurements by assuming the arithmetical mean value to be the true value, the values of the errors thus obtained are called apparent values. The errors as defined are in fixed numerical ratio, thus: if unity represent the probable error the mean absolute error is 1.1829 and the mean error is 1.4826.

If D be the true value of any one of these errors, D' be the apparent value of the same error derived from n measurements,

and D_0 be the corresponding error of the arithmetical mean, the following equations are easily deduced:

$$D'=D\sqrt{\frac{n-1}{n}}. \qquad D_0=\frac{D}{\sqrt{n}}=\frac{D'}{\sqrt{n-1}}$$

For example, suppose the apparent mean error of a gun deduced from 100 shots is 200 yards, then

$$200=D\sqrt{\frac{99}{100}}=.99499D \text{ or } D=\frac{200}{.99499}=201 \text{ yards.}$$

$$D_0=\frac{201}{\sqrt{100}}=\frac{200}{\sqrt{99}}=20.1 \text{ yards.}$$

This means that the value of the mean error which we derive from 100 shots is within one yard of the value we would obtain from an infinite number of shots. Moreover, the mean error of the center of impact of the 100 shots is 20.1 yards. This means that if we fired an infinite number of groups, of 100 shots each, and measured the absolute variation of the mean point of impact each group of 100 shots from the mean point of impact of all the shots and obtained the mean value of these variations, this mean value would be 20.1 yards. If we take 4 times the mean error to be equal to the extreme error and fire a number of groups of 100 shots each, we would expect all the mean points of impacts of the groups to be confined in a distance equal to $8\times 20.1=160.8$ yards. Similarly all the individual shots should be confined to a distance equal to $8\times 201=1608$ yards.

With the value $D=201$ yards (derived from 100 shots) let us see what we may expect in 12-gun salvos.

$$D'=201\sqrt{\frac{11}{12}}=192.4 \text{ yards.}$$

$$D_0=\frac{201}{\sqrt{12}}=58 \text{ yards.}$$

We should, therefore, expect that the spread of a salvo not to exceed $8\times 192.4=1539.5$ yards and the mean points of impact to be confined in a band not exceeding $8\times 58=464$ yards in width.

The foregoing numerical examples illustrate the following points: (a) from the results of firing a comparatively small number of well aimed rounds under conditions as nearly identical as possible a very accurate determination of the true value of the mean error may be made, (b) from the results of such a determination the results to be expected from firing a few rounds from

a single gun or a salvo from a limited number of guns may be predicted, (c) the maximum spread of salvos is directly proportional to the value of the mean error, (d) the mean point of impact of successive salvos of n guns each may be regarded as single impacts made by a more accurate weapon whose mean error is $\frac{1}{\sqrt{n}}$ times the mean error of each gun in the salvo.

Sufficient has been said to indicate the great importance of eliminating or at least reducing to a minimum the elemental accidental errors, thereby reducing the mean error of our guns. Only in this way can we increase the accuracy of the determination of the range by use of the gun and increase our ability to place the mean point of impacts of our salvos at or near the target, thereby increasing the density of impacts over the target area and consequently the probable number of hits. It is useless to theorize about the relation to be maintained between the fire control error and the mean error in order to obtain the maximum number of hits. The fact remains that the fire control error, in the last analysis, must be reduced to the smallest possible and this can only be done effectively by reducing the mean error of the gun to the minimum. When this has been accomplished, if a greater spread of salvo be found to be desirable it can be readily accomplished by deliberately elevating the guns to slightly different angles of elevation without in any way decreasing our ability to place the center of impact at or near the target.

Reference has already been made to constant errors and to errors having unequal positive and negative limits which latter errors may be decomposed into two parts, one part being a constant error equal to the mean value of the error and the other part being an accidental error whose maximum absolute value is equal to one half the difference between limits of the original error.

Of the first type of constant error are those due to maladjustment of sighting devices and those entering into the "Ballistic Correction" and therefore allowed for by that correction. It may be observed, however, that owing to the inaccuracies of the formulæ by which the ballistic correction is computed, a portion of the constant errors remain unallowed for.

Of the second type of constant error are the personal errors of persons engaged in laying the guns. Probably no one's per-

sonal error is constant but varies between limits which in general are unequal in the positive and negative directions. On a moving platform one pointer generally fires too soon, another too late, but neither one by an absolutely fixed amount.

For the above reason salvo firing by pointer fire must generally be inferior to director fire. In the first case the dispersion of a salvo must be increased by the various personal errors of the various pointers. In the second case the dispersion remains unchanged but the salvo as a whole falls too far or too near by an amount equal to the directorscope operator's personal error.

A little experience enables one to estimate and allow for this personal error of the directorscope operator. The same is true of any constant error that exists in all the shots of a salvo.

The process of allowing for such constant errors is much the same as that involved in applying an instrumental index correction to an observed angle.

Where constant errors exist in only a portion of a ship's battery it is very difficult from the results of firing to determine the nature and magnitude of these errors and often their very existence may remain concealed.

For example, suppose a ship having 12 guns mounted in 4 triple-gun turrets fires 3 salvos from each turret singly. There will result 4 groups of 9 shots each. From the fall of shot in each group there may be computed the mean point of impact of each group and the apparent mean error of each shot in the group, and then the true value of the mean error of each shot in a group. There will result 4 values of the mean error of a single shot. If there be no individual errors in the various guns these 4 values will be substantially the same. Suppose D, the real mean error derived from D', the apparent mean error, by the formula $D'=D\sqrt{\frac{8}{9}}$, be equal to 200 yards.

Now the mean error of the centers of impact by turrets will be $D_0=\frac{D}{\sqrt{9}}=\frac{D}{3}$. Treating the four centers of impacts as the fall of four shots the apparent mean error of a single center of impact may be computed and substituted in the formula

$$D'_0=D_0\sqrt{\frac{3}{4}}=\frac{D_0\sqrt{3}}{2}=\frac{D}{2\sqrt{3}}=\frac{D\sqrt{3}}{6}.$$

Now since in computing D'_0 we add the absolute values of the 4 errors and divide by 4, the sum (S) of the errors must be

$$S=4D'_0=\frac{2D}{\sqrt{3}}=D\frac{2\sqrt{3}}{3}=231 \text{ yards.}$$

Therefore, the following errors of the centers of impact by turrets are consistent with the value of $D=200$ yards, and the existence of no turret constant errors.

I	II	III	IV
+75 yards	+40 yards	−40 yards	−75 yards

Suppose now we introduce in turret I a constant error equal to −150 yards and in turret IV a constant error of +150 yards. The errors of the centers of impact become:

I	II	III	IV
−75 yards	+40 yards	−40 yards	+75 yards

It is obvious that such a fall of shot is also consistent with the value $D=200$ yards and gives no indication of the existence of the constant errors existing in turrets I and IV.

If we change the signs of the constant errors in turrets I and IV the fall of shots become:

I	II	III	IV
+225 yards	+40 yards	−40 yards	−225 yards

The existence of errors in I and IV approaching in value the extreme error $4D_0$ would make us suspect the existence of constant errors. Moreover, the apparent value of D'_0, derived directly from this fall of shot, equals 132.5 yards; the value computed from $D=200$ yards, is about 58 yards. Calling D''_0 the apparent value and D'_0 the computed value, we might put $D''_0{}^2=D'_0{}^2+C^2$ and compute C which will be found to be about ± 118 yards. Applying this to the fall we might make a second computation and find $C'=\pm 46$ yards. Applying this second correction we would over compensate by 14 yards.

Such a procedure, however, cannot be adopted except in special cases where other reasons may indicate such a course.

The case cited is simplified by the symmetry of the fall of shot assumed. When no such symmetry exists the situation becomes more complicated.

Suppose in the case assumed we had introduced into I a constant error of −75 yards and into IV one of +75 yards thus

reducing to 0 the apparent error of these two turrets. Now the apparent mean error is 20 yards—much less than 58 yards, its computed value. Yet no one would have the temerity to try to increase its apparent value to its computed value and certainly would not meddle with turrets I and IV where the chances are equal that he would apply the correction in the wrong direction.

From the foregoing one might infer that the detection of constant errors from the analysis of the fall of a limited number of shots would be a hopeless task. In general this is more or less true as regards constant errors of the same order of magnitude as the mean error caused by the accidental errors. *This emphasizes the importance of reducing the magnitude of the accidental errors, for it must be apparent that could these accidental errors be wholly eliminated, thus making the mean error, due to their existence, nil, every constant error would be made to appear in its true sense and magnitude.*

Of course the real remedy for errors, constant as well as accidental, lies in the direction of prevention rather than of cure. Still, much can be done by searching analysis. In the case just cited it is probable that analysis of the individual fall of shot by various combinations of groups would reveal the fact that only the shots from turrets II and III would give entirely consistent results and lead us to infer the existence of constant errors in turrets I and IV. Such analysis might also give us some clue as to their sign and magnitude.

Throughout this discussion I have purposely adopted the mean absolute error as the measure of accuracy of fire. This seems to me to be the only logical measure.

For some time many people have used the size of the so-called "pattern" as the criterion of accuracy of fire and articles have been written with the object of establishing a numerical relation between the size of the "pattern" and the "mean dispersion," dependent upon the number of shots contained in the "pattern." So far as I have been able to determine the term "mean dispersion" is absolutely synonymous with "apparent mean absolute error" as determined from the fall of the number of shots under consideration. The size of the "pattern" is determined by the fall of two shots no matter how many shots may be in the pattern—one shot has the greatest positive error,

the other the greatest negative error of all the shots under consideration.

If there be n shots in a salvo and it is stated that the pattern is d yards in size, the only information really given is that the distance between the two extreme shots is d yards. This means nothing more than that the algebraic difference of the largest apparent positive error and the largest apparent negative error is d yards. We gain no information as to the fall of the remaining $(n\text{-}2)$ shots.

If 10 salvos of 10 shots each have been fired and from the fall of shot the apparent mean error has been computed and we are told that its value is 100 yards, we can immediately calculate that the real mean error is very approximately equal to 100.5 yards and we could make a sketch showing very closely how the shots must have fallen and where the mean points of impact of the various salvos were located.

If, concerning the same firing, we are told that the mean pattern is 500 yards we gain only incomplete knowledge regarding 20 shots—of the remaining 80 we can only infer that in each of the 10 salvos 8 shots were bunched in a space less than 500 yards wide.

Every one knows that a large error of a certain type of gun means a large pattern when salvos are fired by a number of such guns, but a large salvo pattern does not necessarily mean a large mean error. A mean error so small as to be practically negligible combined with a large individual constant error varying from gun to gun in magnitude and sign will give a consistently large pattern. Moreover, the pattern size will give no indication of the existence of these constant errors and might lead to the erroneous assumption of the existence of a large mean error and consequently large elemental accidental errors.

Consideration of pattern size, only, undoubtedly may force upon us the conclusion that we have a white elephant on our hands; it can never indicate the way to rid ourselves of the undesirable animal.

If in the 10 salvos just considered we have means of identifying the shots from each of the 10 guns then we may group the shots by guns and compute the mean error by guns.

If the 10 values thus obtained are substantially the same we may rightly infer that all the guns have the same mean error

and consequently have no appreciable *individual* accidental errors. Now if we compute the mean error by salvos we will get 10 other values. These may or may not be substantially the same. In either case if these values are not consistent with the values obtained by individual gun groups, we may rightly conclude that some or all the guns have constant errors. An inspection of the two groupings followed by a trial and error process will probably indicate the size and magnitude of these constant errors whose elimination will bring the various values of the mean error into agreement. The foregoing reasoning presupposes that all salvos are fired under as nearly identical conditions as possible, such variations as may unavoidably exist should be allowed for by the best available means of correction:

If a successful means of identifying the various shots can be developed, the foregoing method of firing as many all-gun salvos as there are guns in a salvo will constitute the simplest and best method of calibrating a ship's battery.

It has the advantage over methods involving the firing of the guns singly in that all shots are fired under practically battle conditions so far as the actual firing of the guns is concerned.

I have dwelt at some length upon the importance of ascertaining the mean error of our guns at long ranges and then taking such steps as may be necessary to reduce these mean errors to a minimum. Only in this way can we hope to increase the accuracy of our guns to the extent necessary to insure victory in a long range battle.

As has been pointed out, the mean error is simply the algebraic sum of a number of elemental accidental errors. In the rare case in which all these elemental errors have a maximum size and the same sign we have an extreme error which experience shows to be equal to 4 times the mean error. Now, if we can enumerate all these elemental errors and estimate the maximum value of each, it is evident that we may by addition obtain synthetically a value of the extreme error. In general, if we compare such synthetic values with those derived from observational values of the mean error we find the observational value much greater than the synthetic value. We are, therefore, forced to the conclusion that either we have underestimated the size of the elemental errors enumerated or, more likely, have failed to include

in our list of elemental errors one or more whose existence we probably have not even suspected.

So far as the gun and its mount is concerned, they may be considered as having performed their full duty if they deliver the projectile at the muzzle of the gun at predetermined angles of elevation and train and endowed with predetermined translational and rotational velocities.

Recent accurate observations indicate that the angles of elevation and train remain unchanged until after the projectile has left the gun. Such errors, therefore, that arise from variations in these angles must be due to errors in setting.

Proving ground records of velocity firing do not indicate serious variations in muzzle velocities with the same weight and index of charge but persistent effort is being made to reduce existing variations. Recent large caliber experimental firings seem to have brought to light the possibility of large variations in muzzle velocity by the location of the charge in cases where the total length of charge is materially less than the distance between mushroom face and projectile base. When all sections of the charge were placed together at the ignition end of the chamber 3 per cent more than service velocity and 18 per cent more than service pressure were obtained, whereas normal velocity and pressure were obtained when one section was placed at the ignition end of the chamber and the remaining sections were placed at the other end. That such variations may obtain in service seems to be indicated by the result of recent carefully conducted experimental firing of the main battery of one of the capital ships. The firing was at a fixed angle of elevation and included both single gun firing and firing of various groups in salvo including all-gun salvos. Great care was taken to make all loading conditions the same. The range was about 18,000 yards. In every case, without exception, the range of the mean point of impact of each group was, *very uniformly* about 1000 yards greater than the best predicted range that could be made allowing for every known ballistic variation. An increase of 3 per cent over service velocity would account for 700 of the 1000 yards increase found by observation.

Up to the present, little attempt has been made to measure the rotational velocity actually attained by the projectile. In the near future, it is hoped to obtain accurate data upon the rotational

velocity actually attained and also data upon the reduction of rotational velocity that takes place along the trajectory.

After the projectile leaves the muzzle any additional errors that may be introduced is a matter of exterior ballistics and much depends upon efficient projectile design to insure stability and accuracy of flight.

Undoubtedly, the most critical portion of the trajectory is that part where the projectile is still influenced by the powder gases emerging from the muzzle. These rapidly expanding gases are in turbulent motion and rapidly attain a very high velocity, exerting upon the projectile sufficient force to accelerate it for a considerable distance beyond the muzzle of the gun. It seems to me to be highly improbable that the center of pressure for these gases will lie in the longitudinal axis of the projectile. If the center of pressure be eccentric, a couple of considerable magnitude may be brought into play creating a tendency to angular deviation that must be counteracted by the stability of the projectile. It is obvious that an angular variation at the origin of the trajectory produces an increasing lineal error as the range is increased. It is, therefore, highly important to reduce such angular deviation to a minimum.

A possible way of reducing the suddenness of change of conditions as the projectile emerges from the muzzle is to remove a number of the lands for some distance from the muzzle retaining a sufficient number of lands to maintain the longitudinal axis of the projectile coincident with the axis of the bore so long as the projectile is within the gun. This procedure is along the lines which, it is understood, were adopted by the Germans in their long-range gun. It is understood that they left a considerable length of the bore at the muzzle unrifled. Their projectile, being rifled on its cylindrical surface, there was no need to retain any lands in the bore for centering purposes.

The problem of satisfactory projectile design is a complicated one, the solution of which, in my opinion, will necessitate a considerable amount of experimentation. For armor piercing ability, the projectile proper must have a stout blunt point but for ranging qualities the outward form must have a long slender point. This necessitates fixing a long pointed wind shield over the blunt pointed projectile.

In the determination of the stability of flight, the location of the center of gravity, the point where the line of action of the resistance intersects the longitudinal axis, the moments of inertia about the longitudinal axis and about a transverse axis through the center of gravity and the rotational velocity about the longitudinal axis must be considered. The interrelation of these factors is probably very complex and experimental data bearing upon this interrelation is very meagre. Consequently we are confronted at times with results that are difficult to explain. In some recent 6″/53 firing, standard projectiles at 3000 f. s. velocity gave evidence of considerably more accurate flight in a gun rifled 1 in 50 turns than in a gun rifled 1 in 25 turns, in which gun, however, the accuracy was markedly better than in a gun rifled 1 in 37.5 turns. On the other hand, in the 4″/50 with standard projectiles, similar in form to the 6″ standard projectiles, steady flight could not be obtained in a gun rifled 1 in 50 turns when fired at 2900 f. s. velocity but in a gun rifled 1 in 25 turns normal flight was obtained.

These results are difficult to reconcile. The rotational velocity of the projectile fired at 2900 f. s. velocity in the 4″ gun rifled 1 in 50 turns is the same as that which would have been obtained at 3000 f. s. velocity in a 6″ gun rifled 1 in 34.5 turns. It may be more than a mere coincidence that the rifling of the least accurate 6″ gun was not far from this value.

On the other hand, although the shells wobbled considerably in the 1 in 50 4-inch gun, resulting in a mean range considerably smaller than that obtained in the 1 in 25 4-inch gun, the mean dispersion of the low pitched rifled gun was fully as good if not better than that obtained in the gun with the higher pitched rifling.

One may wonder why I have rather harped upon the subject of the mean error and have stated and restated facts that should be obvious to every one.

I have been impelled to adopt such a course because I have observed a too general tendency to adopt an illogical measure of accuracy—a measure that has filled our literature with wailings about the shortcomings of our weapons; spent our energies in more or less futile efforts and has advanced us but little toward the solution of our difficulties.

I remember reading, during the progress of the late war, a lengthy dissertation upon dispersion emanating from a large group of officers, in which was given at length and in detail a list of possible causes of the dispersion of our guns.

These possible causes, if I remember correctly, were as numerous as are the products of the Heinz factories, and so far as I could make out most of these possible causes and all of those popular food products were about equally closely connected with the subject of dispersion.

In my opinion, the first step towards accuracy of fire at long ranges is the determination of the mean errors at these ranges. The second step is to study and analyze these errors with a view to decomposing them into their elemental parts. Lastly comes the elimination or reduction of these elemental errors and the determination of their residual values.

These steps may and probably will proceed concurrently; all involve much time and labor but our achievements in the last step must be the measure of the success of our efforts.

The elimination or reduction of elemental errors, so far as I can foresee, means, for the gun and mount, the greatest accuracy and uniformity of workmanship with minimum tolerances. It means for the foundations an accuracy and rigidity permitting minimum distortions permanent or temporary.

It means for the powder, a purity of materials and accuracy of manufacture, insuring uniformity of finished product so that when made up in charges of fixed weight and length to insure uniform loading conditions it will give uniform results.

Lastly, it means for the projectile a form and disposition of metal that will insure accurate flight throughout its maximum trajectory.

Only by proceeding along these lines we can achieve at long ranges an accuracy of fire to which we can, as politicians say, "point with pride" and in which we can have a confidence, amounting to assurance, of victory in long-range battle.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

TACT IN RELATION TO DISCIPLINE

By Lieut. Commander J. Ogden Hoffman, U. S. Navy

To achieve the greatest results from any organization, civil or military, there must be discipline, tactfully exercised. If the civilian employee refuses to abide by the laws ordained by his employers, he can leave his job or enlist the forces controlled by his labor union, which may or may not support his claim.

In the navy, however, an organization in which everyone, from the highest to the lowest, is serving the same master, the United States of America, there can be no question of refusing to follow the code of written and unwritten laws. These are condensed in the Articles for the Government of the Navy, amplified by the Revised Statutes and personified by the wearers of the naval uniform.

The law, in black and white, is sufficiently detailed to leave few loopholes in the armor of discipline surrounding the service. It remains only, therefore, for the living exponents of the law to so interpret it as to obtain the maximum results.

It is also well for the navy to review its conduct with civilian organizations and individuals and to modify its viewpoint accordingly. It is almost as important to be able to obtain results from someone else's organization as from one's own, and the prestige of the navy depends largely upon the favor with which it is viewed from other circles—in other words, upon its popularity at home and abroad.

A consideration of the importance of tact in its relation to discipline should include all ranks and stations and their conduct, one toward the other. It would be wellnigh impossible to catalogue the different phases of such an elusive quantity, and absurd to prescribe the amount to be used to fit any particular case. The

best we can do is to follow the examples of great men, profit by the mistakes of others, and develop our own personalities along the lines that have been proved to be the most successful.

To anyone who has controlled numbers of men, or who assumes, for the first time, responsibility over others, it is instantly apparent that the proposition differs, somewhat, from anything he has ever done. No two situations are exactly alike, no two men will do things exactly the same way, but they will all produce results if skilfully approached.

Everyone has the privilege of changing his own mind, and the best approach to a new position is to come to it with a perfectly open mind. If the machine is in operation it is wise to quietly sit back and watch it run until the flaws come to light, as they surely will. If the machinery is to be started, organization plays its part and we enter into the discussion of an entirely different subject. We will suppose, therefore, that the plant is running in accordance with the ideas of our predecessor. By "plant" we mean the organization with which we are dealing, be it ship, machine shop, turret or deck division.

The previous incumbent undoubtedly had good ideas, and we should assume, for the present, that everything is running smoothly. In the meantime, we familiarize ourself with every inch of the ground we control, beginning with the matériel, and extending the investigation to the personnel, individually and collectively.

As soon as a new officer steps aboard ship or shore the process of "sizing him up" commences, and it should be mutual, on his part. It will not be long before he has the opportunity of displaying his tact, or the lack of it, and if the first impression that he makes is unfavorable, he will have a hard time to live it down. At the outset he should enlist the services of his seconds in command, obtain their assistance and co-operation. There must not exist the slightest doubt as to who is in charge, but, at the same time, all responsible parties must feel that their voices are heard and their opinions appreciated. If this policy is the opposite to that practised by one's predecessor the situation, at the start, is rather difficult, but will improve with time and the exercise of diplomacy. It recalls an occasion where the engineer officer, finding a certain piece of machinery in deplorable condition, and asking why it had never received attention, was told that the previ-

ous chief got very angry if anyone discovered such a condition before himself. As he had not discovered the defects in question, nothing had been said about it, although his subordinates were thoroughly familiar with the true state of affairs. Such an attitude, on their part, may be a good illustration of "loyalty," but it was rather hard on the inanimate machinery.

One of our foremost organizers used directly opposite methods and, in view of his pre-eminence, they may be considered as standard. A conference having been called to discuss subjects of which all had been forewarned, the topics were taken up, one at a time, and individual views solicited. Having heard what everyone had to say, the master mind came to a decision, which was recognized to be final. Before coming to this decision, advantage had been derived from all the individual opinions and the resultant gained something from each one. We may, therefore, adopt it as an axiom that no two people view a thing in exactly the same way and, even if we consider their opinions of absolutely no value, they will, at least, show us how "not to do it" and eliminate some course that we might have unconsciously considered.

There are many degrees of perfection in the manner in which an order may be obeyed, but unless it is obeyed cheerfully the maximum attainment has not been reached. Much of the grumbling can be eliminated from the execution of disagreeable orders by the exercise of a little tact and by a careful study of the person who is going to carry out the order. On almost every ship there are to be found samples of that peculiar temperament that may perform its duty faultlessly and yet never cheerfully. It is hard to pick flaws in the man's obedience, sobriety, appearance or bearing, and, yet, he always gives you the impression that you have inflicted a personal injury every time you give him an order. Although such an attitude may not impair the efficiency of the work he individually performs, it will undoubtedly have a bad effect on the men who are working with him and there is grave danger of increasing the number of grumblers.

Here we have a situation that is a real problem and which may be solved by a variety of methods. We must, if we can, change the man's state of mind, make him cheerful, improve his influence over his subordinates and associates and, above all, stimulate his loyalty and desire to carry out our wishes. We must not make

him think that we are helpless without his assistance, that he is the only man on the ship capable of filling his particular job, make him a worse grumbler and, in particular, we must not decide that his case is hopeless until we have exhausted every means of approach. Many a good man has been lost to the Service simply because he was not understood, and to understand him is our particular mission, in this case.

This is the situation that confronts us and it must be approached very guardedly and stealthily. Nearly all men can be made to talk and they often reveal conditions that have not been taken into consideration at all. Get them at a time when they are actually doing some work that interests them and discuss the fine points of it with them, like two experts coming to a momentous decision. Having started in this fashion, it is easy to lead the conversation through various channels, until it often ends at the solution for that particular man's "grouch." He probably has been timid about freely expressing himself before, or has suffered in stoical silence, as many of them do. He may be in very real trouble and it is certainly the officer's duty and privilege to give all the consolation the case demands. The enlisted man is often pathetically alone with his personal trouble, although surrounded by a thousand shipmates, and when he feels that someone really cares enough about him to share his burden, life immediately takes on a brighter aspect and efficiency steadily increases. To any of us who have bothered to seriously consider the cultivation of tact and the solution of the personal equation, many concrete examples present themselves.

A man joined the ship in the rating of first-class fireman. In the fire rooms he was worse than useless—all he did was to get in people's way. Although of good physique, he could not throw enough coal to keep up steam in the auxiliary boilers. As a striker in the engine room, he was languid to such a degree that all watches were unanimous in requesting his removal. Finally, he was placed in the machine shop, it being assumed that he could, at least, sort brass turnings from steel and sweep up the shop. The time came to transfer the quarterly War Quota and his name headed the list. On the very day of making out the list a job came up in the shop that puzzled everyone. Strolling up to the machine, this candidate for transfer proceeded to turn out such a perfect sample of accurate work as to make everyone aghast.

He was tried on all the tools in the shop, and there was absolutely nothing he could not do. He could almost make a lathe talk. Regarding his capacity for work, he simply devoured it. Day and night were all the same, he was tireless. It appeared that he had not only served a full five-year apprenticeship in a machine shop, but had completed a night course in a technical college. When asked why, in the name of all that was sensible, he had concealed this ability, he replied, with a slow drawl, that a friend of his had enrolled as a machinist's mate and ended as a third-class fireman, whereas he preferred to go the other way. Luck was certainly on his side, but it also took considerable patience to keep from throwing him into the discard.

One chief boatswain's mate, who carried a very grumbling exterior, also had the ability to do almost anything in a nautical line, but considered small jobs entirely beneath his notice. That is, regarding things like mooring ship, carrying out an anchor or rigging a heavy purchase, he was in his element, whereas the mere evolution of setting up on life-lines or chipping and red-leading the bitts and waterways was too trivial to receive his august attention. The best way to penetrate his armor was to laugh at him. Give him the order, hear all his different reasons why the thing should not be done, then make fun of him and of his aversion to details. Then go on deck, and in a little while you would see a gang of men working like mad to carry out the order, with the chief boatswain's mate driving them like stevedores.

If there happen to be several chronic kickers, a good solution is to put them all in the same part of the ship, within working distance of each other. After hearing each other's songs for a while, the harmony begins to pall and they decide to sing a more pleasant tune. This system worked very well with a pugnacious boilermaker, a humorous coppersmith and a temperamental blacksmith. Each one thought the navy should be run on different lines and refused to help the others except by the constant issue of orders by the engineer officer. The ship was small, the work was arduous and life simply was not worth living with these three, masters of their respective trades, and each one too conceited to take assistance from the others. After placing them in a small, common workshop, a few months brought about a remarkable change. They became like blood brothers, and would meet all comers, in fistic or other combat. Much wielding of heavy sledges

made them dangerous opponents and a little common sense produced a formidable team.

It may be taken for granted that every offender against the naval law commits his breach of discipline with his eyes open and with a fair conception of the result, if his offence is discovered. Unless he enters the service with the avowed intention of starting a career of lawlessness, as soon as he dons the uniform he will have the opportunity of personally witnessing the results of indiscretion and insubordination.

The manner in which these cases are handled will make a great impression on the new man and is bound to affect his future conduct. Men who are punished invariably talk about it afterwards, often with an air of bravado, like the small boy who has been spanked and then walks around, giving the impression that neither his feelings nor anything else has been hurt.

The reduction of the number of offenders to a minimum and the assignment of punishment, when it becomes absolutely necessary, are two of the hardest things that an officer has to do, and ones requiring all of his tact. All of us abhor the discipline that is evidenced by a large daily report list and we dislike the feeling that all sorts of offences are being committed and condoned, or entirely ignored. The latter state of affairs is much the worse of the two, as it indicates a deplorable absence of discipline, as against discipline misguided and carried to extremes. What we should accomplish is, therefore, a reduction of reports to a minimum together with the creation of an atmosphere that leads our subordinates to believe that offences will never be overlooked and that disciplinary action, of some form or other, will always be taken. We might go even farther and establish in the minds of our men the will to do right, not because the opposite conduct is sure to bring punishment, but because the right way to do a thing is always the shortest and best, in the long run. Unfortunately, this state of mind is found in only a comparatively small percentage of the men with whom we have to deal. Some men are instinctively truthful, honest, and are born with the qualities that merit a consistently perfect mark in sobriety and obedience. These men are, however, the exception and still rarer is the man who possesses them and is, at the same time, a skilled and efficient worker.

The first disciplinary dealing with any man, having probably a greater effect on his morale than any subsequent action, should be handled with the greatest care. As a general rule, except for serious offenses, any man deserves another chance before a black mark is entered on his record. The man may even have a bad record from another ship or station and yet a good, heart-to-heart talk will often be just as effective as the most rigorous action. The talk should, if possible, be conducted in private; the language should be simple and forceful, and an appeal made to the man's sportmanship and sense of fairness. Is he going to show that he deserved a square deal or is he going to repay good money with bad, and shatter another illusion of faith placed in human nature? From the majority of cases, it is believed that he will respect the confidence placed in him. If he truly appreciates what has been done for him, his influence will be far-reaching, extending throughout his part of the ship. If the offence is repeated, there must be discipline and let it be swift and sure.

A careful and accurate record should be kept of each man's performance, entirely separate from the meager information that can be entered on his enlistment record. It does not take very long to prepare a card index containing, on each man's card, a current history of all minor offences, special requests, furlough, with the address to which he has gone, and many small notations that form a biography of that man's life on board ship. These details are often most illuminating, and will be forgotten unless recorded when they occur. Men have been kept from getting into trouble by a warning given after consulting just such notes, and, if the system serves no other purpose, it segregates the trouble breeders, agitators and derelicts invariably present among a large body of men.

Too much emphasis cannot be laid on the care with which petty officers should be selected. Once they are rated, they should have the absolute support of the officers. A good and experienced petty officer will, by his own tact and qualities of leadership, deal with slackers and their minor offences and, thereby, lessen the officer's burden. An inexperienced petty officer will have the tendency to report men for minor offences without investigating the cause preceding the effect. If a man is fit to be a petty officer, his orders must be obeyed by those under him and, whether or not he is of long service and experience, any disobedience of his orders must

be considered in exactly the same light as though they had been issued by his superior officer. There is nothing so disheartening to a petty officer who conscientiously reports some infraction of discipline as to have the case dismissed, or a mild warning administered. Such action not only reduces the efficiency of the petty officer, but gives the culprit the impression that toward that particular superior he has nothing to fear, as his exercise of discipline did not receive official sanction.

Gang-spirit exists on board ship, just as it does in any city or town. The men who get into extensive trouble almost always stick together, with the exception of a few isolated cases, as do the men with conspicuously clear records. It is not desired to give the impression that there must be a division between the sheep and the goats, but that an understanding, on the part of the officer, of the divisions among his men will give him an idea of the inner workings of the crew.

Never give an order, unless care is taken to see that it is carried out. Circumstances change so rapidly that, as a rule, it is best to reduce the number of written orders to a minimum. It is very easy for orders to get out of date or to outlive their usefulness and it is naturally most confusing for a new man to consult the crew's bulletin board and final orders several years old, together with more recent editions that may be directly contradictory to the original. It is remarkable how one will find old orders, still kept in the current files, manifestly out of date, and useful only as a cause for perplexity.

In the issue of orders, the greatest tact is required to keep from depriving one's subordinates from all opportunity of exercising their initiative and, at the same time, to have the order carried out as one desires. It deprives subordinates of their sense of responsibility to have them think that the head of the department is never satisfied, unless he has a hand in every minor operation. For this reason, it is thought best to leave details entirely to them. Everything should receive careful supervision and no job is too small to deserve the inspection and appreciation of the man at the top, but he must be very careful that he does not go over the head of one of his subordinates, and sow the seeds of discord. If the work does not suit him, the officer or petty officer in charge is the man to be interviewed, but never the man who is carrying out the latter's orders. This interview should take the form of a dis-

cussion of the relative merits of various ways of doing the work and should not be in the nature of a reprimand, unless an order from superior authority has been disobeyed. If there are several ways of doing the work in question, let the subordinate carry out his own ideas. They may not exactly coincide with one's own views, but the result may be satisfactorily accomplished, just the same. The man's initiative will receive a decided check if every idea of his own is discouraged. When the job is completed he should be told how he could have saved time and labor, if such an improvement is possible, and the next time he has the same thing to do he will be wiser and more efficient.

In discussing the general subject of the tactful handling of men, too much stress canot be laid on the importance of learning to call each one by name. This should be one of the subjects to which a newly arrived officer devotes himself, and he should not be satisfied until he knows and remembers the name of every man with whom he has to deal. It is astonishing how much more snap and alacrity will be put into the execution of an order, if a man is addressed by his own name, instead of being classed under the general category of "you." When the number of men reaches up into the hundreds, it is certainly difficult to catalogue them all, but the subject should be diligently pursued, starting at the top and working down, until they have all been mastered. The fireman leaning on his slice-bar or the seaman on his squeegee-handle (two characteristic attitudes) will forget his day dreams very quickly by hearing his name called by someone to whom he thought he was, more or less, incognito. His first attitude is usually one of surprise, followed by the impression that he must be pretty good, after all, to have been noticed. As soon as a man begins to feel that he is not merely a cog in a big machine, but a living personality, whose existence really affects the big scheme of things, he begins to try a little harder to justify the belief. The making of many a petty officer dates from that moment.

All of us have felt the thrill of pleasure that comes from being addressed by name by someone whose notice we thought we had entirely escaped. With some officers it has become the habit of a lifetime, and many captains know the name of every man in their crew. Men who have seen naval service are found holding positions of trust all over the country, and it is surprising how one meets old shipmates in most unexpected circumstances. The man

is much the more likely to remember his officers' names, as we are all more observant of our superiors than of our juniors, but when the recognition is mutual we can make a real entry on the credit side of our memory ledger.

It is hard to say whether more tact is required in dealing with officers than with enlisted men, but it may be admitted that the effect, in the majority of cases, will be more quickly perceptible with the men and more lasting with the officers. Here, again, we cross the paths of psychology, human nature and the personal equation. Every man, commissioned or enlisted, is a distinct human problem and the more highly strung and nervous the temperament the more the required tact. A high-spirited horse is put in a perfect frenzy by a single touch of the spur, while the steady plodder may be only slightly accelerated by consistent and steady driving, although the effect will accumulate very gradually.

The only way to determine the particular kind of goad that will do the most good is to study all the details of the nature that confronts us. Some people will take the slightest hint, while with others the point of the argument must be as broad as their hand before they can see it and have it penetrate to the inner consciousness. Resentment instantly flares up in some natures, while others will stand any amount of chaff without harboring the least malice. Some people seem to be absolutely devoid of a sense of humor, while others will see the comic side of almost any situation and laugh away the most serious difficulty by sheer good nature.

The golden rule always works both ways. In other words, we must be tactful with our superiors and peers, just as we are with our juniors. A very wise captain once gave one of his officers the following advice: "If the captain reproves you for something you have not done, or your superior officer finds fault with something that you know is absolutely right, just stand and take it, and keep quiet unless your opinion is asked. In either case, if you were right, the other will soon find it out, and his opinion of you will rise, as he then knows that you knew he was wrong and did not tell him so." On another occasion the captain, upon going ashore, left orders for a boat to meet him at a certain landing at a certain time. The officer-of-the-deck despatched the boat, but the coxswain, who happened to be a relief and not the regular man for the boat, went to the wrong landing. The officer-of-the-deck became worried at the non-return of the captain and

called away another boat. It was at night, the crew had to be turned out, the engine was cold and took long to start, and when the second boat got to the landing the captain had been kept waiting nearly an hour. The officer-of-the-deck reviewed in his mind all the possible punishments that might be his due, ranging from a severe reprimand to a court-martial. When the captain came on board all he said was, "Nice dock they have over here," and went below. The junior officer will probably never forget the occasion to his dying day, and it is quite certain that the interests of discipline were satisfied.

When we deal with people from other walks of life and of different customs from our own, we must do as they do, if we wish to realize our own aims. This applies to our dealings with civilian employees and, to a still greater measure, to our conduct with foreigners. In either case, their methods will not be ours, and the best policy is to let them go ahead in their own way, even though it grates on our nerves and strains our patience to the breaking point. The point to remember is that *we* wish to accomplish something, and we cannot do it without *their* help. To anyone who has wasted time trying to conduct business, along American lines, over a foreign telephone, no further illustration will be necessary.

To condense all that we think about, or have said, concerning "tact," resolves itself into an elaboration of the golden rule, with the mental note that, although few people are born with a hundred per cent, we can all study to reach a passing mark. Try to see a thing through the other fellow's eyes, and then combine that with the best possible way of achieving your own ends. You deserve a *perfect* mark when you make him do something just as you wish it, and have him think, all along, that he is doing it exactly his own way.

In naval circles a *cheerful* "Aye, aye, sir," is the acme of good tact, good discipline and good technique.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

SKETCH OF PRESENT RADIO SITUATION INFLUENCE ON TACTICS AND STRATEGY[1]

By LIEUT. COMMANDER S. C. HOOPER, U. S. Navy

The two largest radio concerns in the world are the British Marconi Company, of England, and the United States Naval Radio Service. The British Marconi Company is one of the most important commercial institutions backed by the British Government, and its lines of communication extend over Europe, India, Africa and Canada, with connections to the American Marconi Company in the United States. The United States Naval Radio Service comprises high-power radio stations on both coasts of the United States, in Panama, the Caribbean, Hawaii, Guam, the Philippines, Alaska, Peking, Vladivostok; in addition, all coastal radio stations in the United States, for communication between ships and the Coast, with four exceptions, are owned and operated by the United States Navy. There are about 120 of these stations. Each air station, there are about a dozen in all, is equipped with a naval radio station for the purpose of communicating with airplanes and dirigibles on patrol, for distances of several hundred miles from shore. The navy is developing in addition, a system of navigational radio stations (see appended list) on both the Atlantic and Pacific coasts for the purpose of assisting ships at sea in determining their positions. These latter are especially useful for vessels approaching the coast in thick weather. There are about 50 navigational radio compass stations completed. All naval vessels and all vessels of the United States Shipping Board are equipped with naval radio apparatus, operated by naval radio-men[2]; also vessels of other branches of the government, including the coast guard, light vessels of the Department of Commerce, and the army. The army maintains and operates its

[1] This paper was submitted November 1, 1918.

[2] Naval radio operators removed July 1, 1919.

own radio apparatus except for transports. There were nearly 5000 United States naval radio operators on watch on the ships of the seven seas on January 1, 1919, and a large personnel is required on shore to maintain and install the equipment. Prior to the entering of the United States into the war there were but about 500 operators in the service, with but some 50 radio stations. There were, at the signing of the Armistice, over 5000 men in the service and about 150 stations. The number of shipboard and airplane sets in service has increased from about 400 to about 4000. In addition, a large number of listening-in section base stations were established during the war, but these were of a temporary nature and have since been abandoned. Also the radio service equipped about 15 air stations abroad with naval radio apparatus.

One of the largest problems assigned to the naval radio service at the beginning of war was the development of a transatlantic radio system capable of replacing the cables. Early in the war some of the cables became disabled, being cut by German submarines and otherwise, and it became impossible to repair them due to the torpedoing of cable ships by submarines. It was feared that the entire cable service might at any time become disabled due to submarines. At that time it was only possible to rely on radio communication across the ocean during certain times of the day when static and absorption of signals was a minimum and only about 30 per cent of the time during the summer months. Within one year various improvements were made and new stations constructed, and old stations equipped with new apparatus to the extent that to-day we are able to handle about one-third of the cable business by radio. During the past summer the total reception of signals, both ways, averaged 98.5 per cent as compared with 30 per cent the previous summer.

One of the principal means of increasing the traffic has been the introduction of automatic high speed transmitting and receiving apparatus. Certain stations are now being operated automatically at speeds of from 50 to 100 words per minute as compared with an average of less than 20 words per minute when using hand sending. All reception from Europe, from the high power stations in Lyons, Rome, Nauen, Carnarvon (Wales) and Nantes (France), is done at Otter Cliffs, near Bar Harbor, Maine, and direct wires to Washington are used to communicate the messages to Washington. The transmitting keys at the high

power stations in the United States are operated automatically by means of distant control lines from the keys located in the Navy Department, Washington. For example, the key in the Annapolis Station is pressed by the operator in Washington. During the war two additional receiving stations were maintained at Belmar, N. J., and Washington, respectively, for receiving signals from Europe. These stations were considered as stand-by stations and only supplied the parts of the messages which Bar Harbor failed to copy. The two greatest obstacles to reliable trans-oceanic communication were static and destruction of aerials by winter ice and winds. The static was overcome by using combinations of underground receiving aerials and balanced loops. The difficulty due to breaking of aerial wires by ice forming on the wires was overcome by heating the aerial wires by means of direct current supplied from the main generating machines at the radio stations.

The high power apparatus used is generally the arc and the Alexanderson alternator. Both are quite efficient. The alternator is slightly superior to the arc.

Following the surrender of the German Navy our experts have had an interesting opportunity to compare our own radio apparatus with that of the Germans. It had always been the opinion, among the officers of our own service, that the German apparatus was far superior, as the Germans were so noted as scientists. Greatly to our surprise it was found that the German ships not only were equipped with inferior apparatus, but that they had not equipped their vessels along the line of most recent developments in direction finders, submarine listening-in devices, and sharply tuned instruments. These secrets must have been known to the Germans and the experts are at a loss to understand this lack of equipment on their vessels.

Recent naval radio development has been along the following lines:

(1) Radio compass, for taking bearings by means of received signals.

(2) Radio telephone.

(3) Radio applied to aircraft.

(4) Increased ranges for communication.

(5) Improvement in sharpness of tuning, resulting in larger number of simultaneous communications, without interference.

(6) Underwater reception of signals.

(7) Fire control by radio.

The Radio Compass.—A large number of ships, principally destroyers and transports, have been equipped with the radio compass. This instrument consists of a receiver and an aerial, the latter being merely a revolving coil about four feet square. When the coil is in the plane of the incoming signal, the apparent signal intensity is greatest. By this principle the bearing of an incoming signal can be measured, at distances up to about 50 per cent of the distance of ordinary reception from any particular transmitting station. The time consumed in taking a bearing is about one minute. The accuracy of the reading depends principally on the personnel. It takes several weeks of constant practice for an operator to become an accurate measurer of radio compass signals. At least once a year the curve of errors for the radio compass should be determined by swinging ship, in a manner very similar to that used for determining deviation for the standard compass. With a carefully calibrated radio compass, a gyro repeater mounted in the radio compass room for comparison, and an experienced operator, it is possible to obtain accuracy on board ship within one or two degrees.

There are shore radio compass stations near the entrances of each of the principal harbors on the Atlantic Coast, including Boston, Newport, New York, Delaware Capes, Chesapeake Bay entrance, and Charleston. A ship may call for position within 200 miles of any of these stations and obtain it with a fair degree of accuracy. The nearer the ship is to the compass station the more accurate becomes the position given by radio. It is reasonable to expect roughly an average of one-quarter mile error close in shore, one mile at a distance of 20 miles, two miles error at a distance of 50 miles, and four miles error at a distance of 100 miles. The fact that the radio compass bearing is fairly dependable should not in any way relieve the navigator of the ordinary precautions, such as taking soundings and reduction of speed when nearing port in thick weather.

From the foregoing it becomes evident that the adoption of the radio compass to naval use introduces a new factor which must be considered in naval strategy, for being able to obtain the location of a ship by means of radio means that there must be very little radio signalling carried on by opposing forces in war

time, if they desire to avoid being located accurately, by the other side.

By virtue of the use of radio telegraphy, it has become the practice for the force commander to shift his arrangement and disposition of forces quickly from time to time, as circumstances develop, merely by radio. The radio compass makes the use of radio increasingly dangerous, and requires more careful planning in conferences and written instructions in advance. Study must, therefore, be given to means of circumventing this situation. In the first place it may be desirable to detail special decoy ships for the purpose of using their radio in an endeavor to mislead the enemy as to the strategic intentions; secondly, the power used for tactical maneuvers must be limited to the range of visibility, in order that the force commander's signals may not be overheard by the enemy; and thirdly, it will be necessary to arrange that the necessary exchange of radio information, using high-powered transmission, be done by means of messages so brief that the opponent operators will not have sufficient time to adjust the compass for the purpose of obtaining a bearing. This may require the rearrangement of the signal book in such form that a short code word will be sufficient to transmit a considerable amount of information. Shifting widely between wave lengths at predetermined intervals may be of some assistance in avoiding the enemy's compass listeners, in this respect.

A careful and systematic arrangement must be developed by our own vessels, and by the establishment of additional listening-in compass stations, in order to insure that our operators may hear and locate the signals of any enemy craft which transmits by radio.

By virtue of the ability of the shore radio compass stations to give the navigator an accurate position regardless of visibility conditions it is possible for the fleet to make port under weather conditions which would otherwise render this difficult if not impossible. Therefore, the radio compass is an instrument which will greatly assist the commander-in-chief in greater freedom of movement by making quick retreat to a friendly port always possible.

Scouting airplanes and dirigibles are being equipped with radio compass outfits which will be of great assistance to these

vessels in returning to port, and in locating their mother ships at sea.

By using the radio compass it is possible easily to make contact possible between vessels of our own fleet, in thick weather. This instrument proved valuable in this respect, during the war, assisting escorts to make contact with troop convoys, contact in thick weather being a matter of chance without the radio compass.

The Radio Telephone.—This instrument has recently been supplied to practically all naval vessels, and has proved particularly useful for aircraft signalling, for maneuvering submarine hunting squadrons, and as a convenience in the fleet at anchor, for arranging about supplies, athletic events, etc., where flag signalling is too slow and cumbersome. Experiments are being made by the fleet to determine whether the radio telephone will prove superior to the radio telegraph for tactical maneuvers. In the course of two or three years the art will have sufficiently advanced to make possible simultaneous use of the telephone and telegraph, without interfering one with the other. At present this is not practicable, and the telegraph must be silenced when the telephone is in use and vice versa, when used on the same ship.

The telephone will probably be found to be inferior to the telegraph for strategical purposes due to the difficulty in speedily transmitting cipher and code by telephone as compared to the telegraph, also to the fact that military information may be more concisely and clearly transmitted by carefully worded message. The telegraph is less likely to err than the telephone. Therefore it would appear that the telegraph will always be the primary means of communication for strategical purposes, and probably for tactical purposes. For convenience in administration the telephone will undoubtedly prove superior to the telegraph, but the use of the telephone will have to be carefully regulated in order not to interfere with the telegraph, at least until the art has solved the problem of simultaneous use of both.

For aircraft, where saving in weight is such an important factor, the telephone is preferable to the telegraph, as an additional man as operator is not necessary, the pilot himself doing the talking. Possibly as aircraft becomes larger and the weight factor becomes less important, the same rules will apply to the use of the telephone *vs.* telegraph for aircraft, as for ships.

Small tactical groups of vessels, such as subchasers and aircraft used in hunting submarines, find the telephone indispensable, as much information of value can be quickly transmitted by telephone which would be impossible by telegraph, due to the special nature of the work.

The radio telephones installed on naval vessels are efficient for communication for ranges of 20 miles, often much greater; those on subchasers and smaller craft for ranges of 10 miles. One of the transports carries an experimental radio telephone capable of transmitting voice 800 miles.

Radio Applied to Aircraft.—Airplanes and dirigibles used as scouts are dependent upon radio to provide communication with their flagships and with the bases on shore. Spotting planes are equipped with radio for reporting fall of shots.

Two types of apparatus are furnished airplanes; short range (5 miles range) telephone transmitters for use in spotting planes and for maneuvering planes in formation; and long range combined telephone-telegraph transmitters for use in scouting machines. The latter have a range of roughly 150 miles when using telegraph. When using telephone the range is reduced to about 75 miles due to the difficulty in receiving telephone through the noise of the airplane motors. Dirigibles are equipped with 200-mile range transmitters, combined telephone-telegraph type.

A direction finder (radio compass) is now being supplied the latest type airplanes. By means of this instrument airplanes should be able to navigate back to their bases and mother ships in foggy weather. The airplane radio compass is efficient up to ranges of 75-100 miles when receiving from ordinary coastal and ship stations.

The principal influence on strategy, because of radio on aircraft, is to increase the radius of action of the airplane as a scout. Its value in tactics concerns the quick and accurate report of fall of shots. Spotting by aircraft observers will increase the accuracy of fire two or three hundred per cent, providing the radio is skillfully used.

Increased Range of Communication.—The range of radio has been greatly increased in the past two years due to the improvement in amplification of signals in the receiver and in anti-static antennæ, also to increased efficiency in transmitters. Battleships, flagships, cruisers, and fuel ships have been equipped with arc

type transmitters having reliable transmitting ranges of 800 miles by day (1500-2500 miles by night). A certain proportion of destroyers are being equipped with arc type transmitters which may be expected to give reliable ranges by day of at least 500 miles (over 1000 miles by night). The majority of destroyers have a reliable radio range of 300 miles by day. Improvements in receiving arrangements at shore stations has made reliable trans-oceanic communication possible. This is important from a strategical standpoint, as cables are very easily interfered with by submarines. It is not only possible for a submarine to cut a cable but it is a simple matter for the submarine to listen in, by inductive means, to the cable conversations, thereby intercepting the messages. This should be borne in mind in war time, and great care given to the careful enciphering of confidential cable messages. The efficiency of the trans-oceanic radio service has advanced to the stage wherein active competition with cable lines is practicable. Whether the radio will ultimately replace the cables is a matter of conjecture. Radio communication is cheaper than cable communication due to low initial and maintenance costs. The future of radio in this connection depends largely on whether the advance in the art will be sufficient to accomodate sufficient numbers of pairs of communication without causing too much interference.

Underwater Signalling by Radio.—It is now possible for submerged submarines easily to receive radio signals from ships, shore stations, etc. Efficient reception underwater from aircraft in flight is not yet practicable. A submarine can cruise with its aerial submerged 10-20 feet below the surface and overhear the various radio conversations which are carried on. To date no means have been developed by which the submarine effectively transmits radio signals using a submerged aerial.

Use of Radio for Fire Control.—Radio is of great value for fire control purposes generally, not only for airplane spotting in the fleet, but for artillery spotting on shore, and for concentrating the fire of several batteries on one target, also for exchanging ranges between fire control stations. Difficulties due to interferences between many stations operating within limited areas are being overcome by replacement of old type apparatus with modern continuous wave sets, and the addition of directional receiving aerials.

The use of radio for military purposes and for commercial purposes is increasing with rapid strides. The control of the aerial torpedo by an airplane is pretty well perfected, and there is considerable hope that an underwater torpedo controlled by radio from a guiding airplane will develop as a useful weapon. The limit of power of large caliber guns seems to have been about reached and for longer accurate ranges the radio controlled torpedo is the logical line of development, therefore our tactics and strategy should be guided with this in mind. We must look to the day when the aircraft, radio, torpedoes and submarines play most important rôles in naval warfare.

The use of the various radio facilities which are possible is dependent entirely on skilled personnel. It is absolutely essential that the radio officer of each capital ship, and of each flotilla or group of destroyers, submarines and aircraft, be a skilled operator and constantly on the "wire." Failing in this no advance is possible. Flag officers can do the greatest good in advancing present day development by taking a keen interest in insisting on this important point. The whole future of strategy, tactics, information, fire control, and torpedo control is absolutely dependent upon radio telegraphy and radio telephony. This must be recognized and suitable provision made properly to develop personnel, material and operation plans to anticipate the situation.

RADIO COMPASS STATIONS

ATLANTIC COAST

Cross Island, Maine.
Bar Harbor, Maine.
Damiscove Island, Maine.
Appledore Island, Maine.
Gloucester, Mass.
Deer Island, Mass.
Fourth Cliff, Mass.
Cape Cod, Mass.
Nantucket, Mass.
Chatham, Mass.
Price's Neck, R. I.
Watch Hill, R. I.
Montauk, L. I., N. Y.
Fire Island, N. Y.
Rockaway Beach, N. Y.
Sandy Hook, N. J.
Mantoloking, N. J.
Cape May, N. J.
Cape Henlopen, Del.
Bethany Beach, Del.
Hog Island, Va.
Smith Island, Va.
Cape Henry, Va.
Cape Hatteras, N. C.
Cape Lookout, N. C.
North Island, S. C.
Morris Island, S. C.
Burrwood, La.
Pass a Loutre, La.
Grand Island, La.
St. Augustine (Projected).

PACIFIC COAST

Point No Point, Wash.
Admiralty Head, Wash.
Smith Island, Wash.
Cattle Point, Wash.
Lime Kiln, Wash.
New Dungenes, Wash.
Slip Point, Wash.
Tatoosh Island, Wash.
Ozette Island, Wash.
Ocean Park, Wash.
North Head, Wash.
Tillamook Head, Wash.
Fort Stevens (Clatsop Spit), Oregon.
Cape Arago, Calif.
Eureka, Calif.
Point Reyes, Calif.
Farallon Islands, Calif.
Bird Island (Point Bonita), Calif.
Point Montara, Calif.
Point Arguello, Calif.
Point Conception, Calif.
Point Hueneme, Calif.
Cape Avalon (Santa Catalina), Calif.
Point Loma, Calif.
Chy, Calif. (Imperial Beach).

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THE *ST. LAWRENCE* AND THE *PETREL*

By JAMES MORRIS MORGAN

Few people now living are aware of the fact that the states of Louisiana and South Carolina had navies separate from the Confederate States and fewer still know that people in the Confederacy fitted out privateers, but imagine that it is the proper thing to call the de facto government-owned ships, such as the *Alabama,* etc., "privateers." Now a privateer is of course a vessel owned by a private party and sails under the protection of a "letter of marque" to prevent their crews from being treated as pirates in case of capture. The United States Government settled the matter to its own satisfaction by branding everything afloat which belonged to the Southern Confederacy as pirates—and this brings about an interesting question, as it is well known that the definition of a man-of-warsman or navy sailor is "a sea soldier" or "a soldier that fights on water." Now it was all right for the soldiers of General Sherman's army to burn hundreds of houses on their "march to the sea," because, I suppose, the houses were on land, but it constituted an act of piracy according to the government of these same soldiers when a Confederate sailor burned a ship on the high seas; and what is a ship if it is not both a dwelling and a floating warehouse? Now to follow out this line of reasoning to its natural conclusion: if a soldier belonging to a "de facto" government becomes a pirate when he goes in a boat on the water, then naturally every time General Lee's army crossed a river on pontoon bridges by that act they also became a band of pirates. But I am drifting away from the South Carolina navy.

Prior to the Civil War the United States Government had a class of revenue cutters that were unique in their yachty appear-

ance. They were, of course, small, being topsail rigged schooners, and as they were built to catch smugglers naturally they were exceptionally fast. One of these cutters, the *Petrel,* was stationed in Charleston harbor at the time of the secession of the state and was at once seized and turned over to the South Carolina navy. The armament of the *Petrel* consisted of one 18-pounder, or "Long Tom" as the little gun was affectionately called by the sailors. This gun was mounted forward of the foremast.

A very young master's mate with more enthusiasm than experience was given the command and he put to sea in great haste as he feared that two local privateers, a little brig called the *Jeff Davis,* and a little tug, mounting one 32-pounder, called the *Lady Davis,* which were cruising outside of Charleston bar, would gobble up all the prize money before she, the *Petrel,* would be able to get in her fine work.

Getting into the Gulf Stream the *Petrel* cruised for days without success until one day her boy commander saw what he was sure was fortune, coming fearlessly toward him, in the shape of a big East-Indiaman with dirty sails and yards all askew; and what made the youngster doubly sure of his prize, was the way in which the ship was painted, black with a white stripe around her in which was painted camouflage black gun ports. All East-Indiamen used this deception to make them resemble (at a distance) frigates and the Chinese pirates were supposed to take fright at the sight, and instantly seek safety in flight. But the supposed disguise did not intimidate the *Petrel's* young captain a bit. He gallantly bore down on the supposedly doomed ship and signaled her to "heave to," to which signal the big ship paid no attention. Then more sail was set on the *Petrel* and she easily headed the lumbering old craft. When she got to within some 300 yards of her a shot from the Long Tom was sent across the supposed Indiaman's bows as a peremptory notice that she had been ordered to stop!

"*Rien n'est sacré pour un Sapeur,*" as the French poilu said when he picked the lady's lap dog up by the tail—and the tale of what followed that shot which went skipping over the waves is more dramatically and tersely told in the language of the *Petrel's* boy skipper when a lot of irreverent midshipmen insisted upon his giving them a full description of that memorable combat in

which he had borne such a conspicuous part. His account of the engagement was as follows:

> Just as I fired the shot across the bows of the supposed old water bruiser her whole side seemed to fall apart and for an instant I saw a sheet of flame reaching from her stem to her stern followed by a terrific crash and roar as of thunder. I distinctly felt a jar, and after a time I came up spouting water like a half-drowned whale. And that is all I know about the fight between the United States 50-gun frigate *St. Lawrence* and the Confederate States 1-gun cruiser *Petrel.*

While in the Gulf of Mexico the *St. Lawrence* had heard of the doings of the toy cruisers or privateers in the Gulf Stream off Charleston and she proceeded to investigate, but her commander never dreamed that his camouflage to look like an Indiaman would succeed to such an extent that a toy boat like the *Petrel* would sail up to within a few cable lengths of the frigate without discovering the ruse, and then boldly open fire on a fighting ship much more than 50 times her superior.

The youthful commander of the *Petrel* realized the truth of the old yarn about the sailor who once "got religion" and while reading his Bible came across the verse which says that "those who go down to the sea in ships see the wonders of the Lord." He stopped and scratched his head and after cogitating for a while he said: "Well of course that must be so as everything in this book is true, and now that I come to think about it I never did make a voyage in a full-rigged ship, but I can tell the fellow that wrote that this, and that is, that those who go to sea in barks, brigs, schooners or other small craft—they see hell!"

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AN APPLICATION OF THE METHOD OF ANALYZING THE ENGINEERING PERFORMANCE OF DESTROYERS

By Lieut. Commander Wentworth H. Osgood, U. S. Navy

I. Outline of Article

This article is written with the purpose of explaining by means of definitions and specific examples the elements which, taken together, constitute a complete analysis of the engineering performance of destroyers; the object being to give simple and practical explanations of these elements, in order that they may be used daily aboard ship toward the more efficient and economical operation of the engineering plant.

The following outline will be pursued: The units and terms employed will be defined as they apply to the subject-matter, rather than the absolute scientific definition. Practical values of the foregoing defined characteristics will be given for each machinery unit by means of the simplest and most useful curves that can be employed. A concrete example of performance will be given and worked out. This will be explained, the explanation serving to show the method of handling the data, and the detection of faults in the operation by means of this analysis. Finally, suggestions for the practical application of this analysis aboard ship will be given. The installation aboard the U. S. S. *Blakeley* (150) is the basis of the analysis.

II. Units and Terms Employed

The units and terms as defined below are in the simplest and most useful form for this analysis. It is understood that most of these terms and units should be corrected for the various conditions other than the standard conditions to which all test results are reduced for comparison. For the actual use of this method aboard ship these corrections are omitted, but in case the informa-

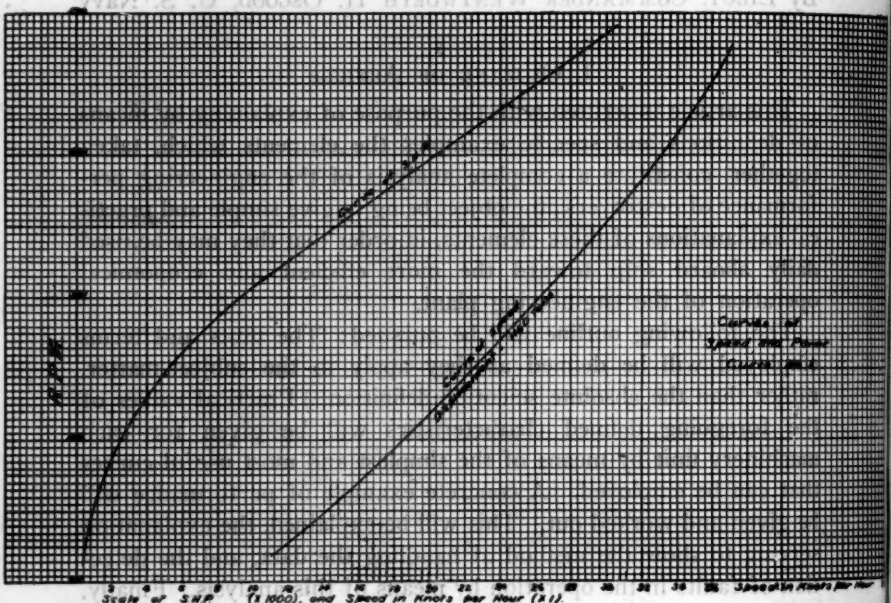
tion is desired it can be found in the standard engineering handbooks and especially in the Power Test Code of the A. S. M. E.

I. UNITS EMPLOYED

Notation for Power Formulæ

P = Mean effective pressure from indicator in pounds per square inch.

P_1 = Mean effective pressure of the air end of compressor.



L = Length of stroke in feet.

A = Area of piston less one-half area of piston rod in square inches (net area).

N_1 = Number of single strokes per minute.

N_2 = R. P. M. or double strokes per minute.

W = Net weight or pressure on brake arm in pounds.

L_1 = Effective length of brake arm in feet.

[1]H = Total head in pounds per square inch.

[1] This total head H is made up of the pressure in the suction line being added to the pressure of the discharge side of a pump.

H_1=Head as above, in feet.
Q =Quantity of water in pounds per hour.
Q_1=Quantity of water in gallons per minute.

$$Q=7.20\ Q_1 \text{ (fresh water).}$$
$$Q=7.02\ Q_1 \text{ (salt water).}$$

One horsepower=33,000 foot pounds per minute.
One horsepower=550 foot pounds per second.

Indicated Horsepower

$$\text{I. H. P.}=\frac{PLAN_1}{33{,}000}=PN_1\left(\frac{LA}{33{,}000}\right).$$

Brake Horsepower

$$\text{B. H. P.}=\frac{\pi WL_1N_2}{33{,}000}=WN\left(\frac{\pi L_1}{33{,}000}\right).$$

Water Horsepower

$$\text{W. H. P.}=\frac{HALN_1}{33{,}000}=HN_1\left(\frac{AL}{33{,}000}\right).$$

$$\text{W. H. P.}=\frac{Q_1\times H_1}{K}.$$

$$\text{W, H, P.}=\frac{Q_1\times H}{K_1}.$$

	Salt water	Fresh water
K	3890	3860
K_1	1680	1710

Air Horsepower

$$\text{A. H. P.}=\frac{P_1ALN_1}{33{,}000}=P_1N_1\left(\frac{AL}{33{,}000}\right).$$

NOTE.—The above formulæ can be used for reciprocating compressors. The air horsepower of the fire-room blowers is found from formulæ that contain elements which require special measuring apparatus (not supplied to ships).

The "pound of steam" is taken as the unit of energy input. The real energy is the number of B. T. U.'s of heat contained in the pound of steam at the existing pressure; this value can be found in any steam tables or handbook; but as the steam is the actual medium that is measured and which the boiler gives off, even though it is just the "carriage" for the actual energy, it is the one used to represent the input.

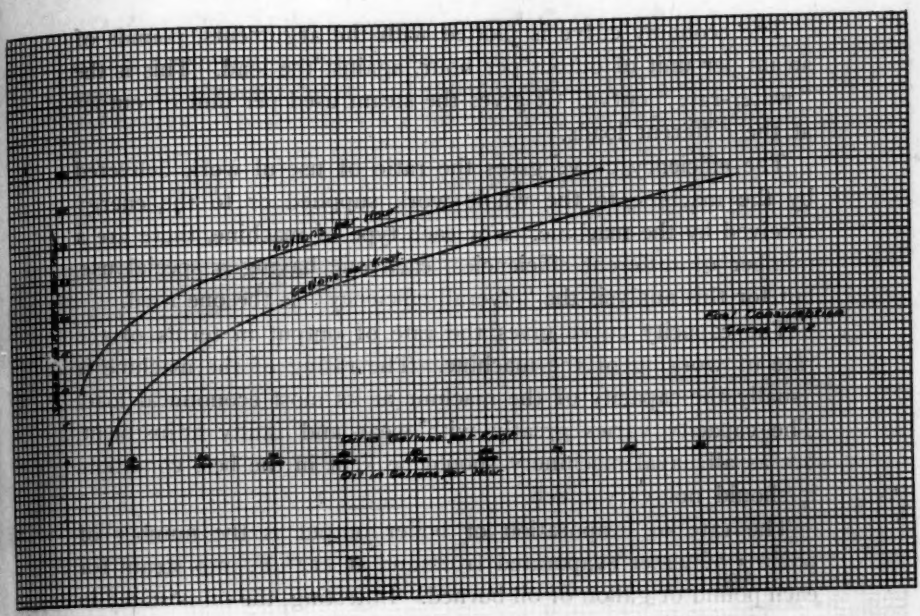
The "water rate" is the number of pounds of steam that a machinery unit uses in a unit of time, usually an hour. As an

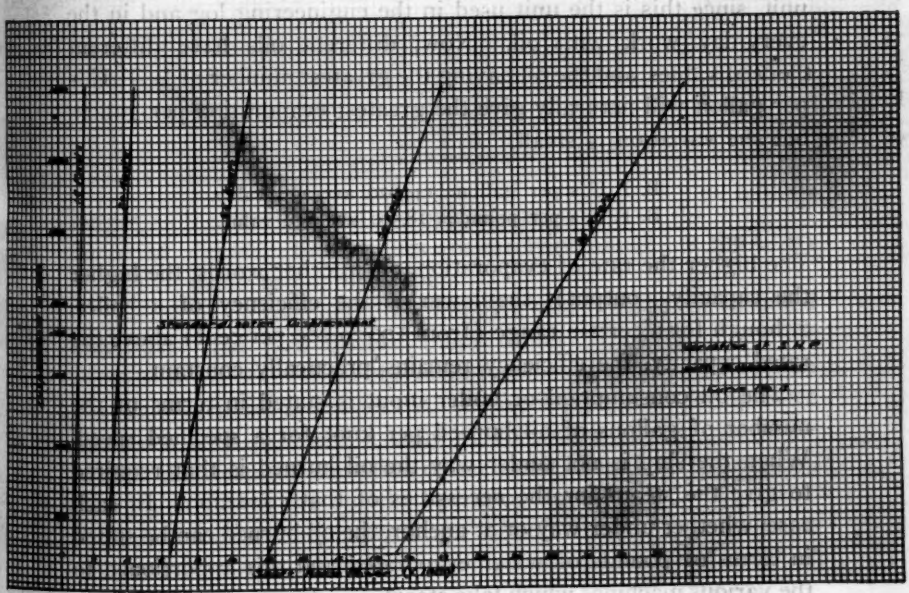
example, if a pump has a water rate of 50 pounds per horsepower hour at a certain pressure and rate of output, it means that 50 pounds of steam at a pressure of, say 200 pounds, is being supplied to the pump each hour for each I. H. P. The heat which actually does the work is caried by the steam and from the steam tables amounts to 1198 B. T. U.'s per pound. Therefore $50 \times 1198 = 59{,}900$ B. T. U.'s are supplied to do the work of each I. H. P. Although much of this heat is wasted owing to the unavoidable inefficiency of the machine, nevertheless, it is the energy supplied or the input.

The criterion of the final performance should always be the "gallons per knot"; that is, the number of gallons of oil that are required to drive the ship a distance of 1 knot at the various speeds as defined above. This states, in other words, that so many gallons of oil burned under the boiler supplied just enough steam for the main engines and all necessary auxiliary machinery (including generators for lighting, etc.) to drive the ship a distance of 1 knot at a speed of so many knots per hour. Naturally, the faster the ship goes, the more oil will be required to go the same distance. This is shown on Curve 2. For other than standard trial displacements the relation between the horsepowers required are shown on Curve 3.

2. TERMS AND THEIR INTERRELATIONS

The Willan's line is a curve plotted with the arguments, "input," or total steam used per hour, and "output," or the work done by the machine, expressed in appropriate units. The output of a generator is in kilowatts; of a pump, in gallons per minute; and of an engine, in horsepower, etc. The load or output (abscissa) should be given in terms of revolutions or strokes of the machine as these are easily determined. This can be done since all of the machines work under practically constant conditions. The feed-pump works against the boiler pressure of 260 pounds. A fire and bilge pump when on the flushing system runs steadily at a pressure of 10 or 15 pounds, and when on the fire main at 70 pounds, and so on. The main turbines at a specified R. P. M. are pushing against a steady load. In other words, the strokes or R. P. M. of a machinery unit can be taken as the direct measure of the power developed. (See capacity curve.)





The economy curve is plotted with the arguments, pounds of steam per unit of output per hour, against the load. This is the "water-rate" curve. It gives the steam used per unit of output at the different loads.

The efficiency curve gives the ratio of useful work delivered by the machine to the whole work supplied or to the energy received by the machine. For each type of machine, there are a number of different efficiencies, each one having a special use, but for this analysis the "overall efficiency" is the one used.

The capacity curve gives the rate of output in terms of the rate of working of the machine. The rating of the machine is usually the capacity of the machine at its most economical load The capacity varies greatly with wear and faulty adjustment, but as all naval machinery should be kept in the best condition, it should not vary much.

The rate of evaporation or boiler output is the number of pounds of water evaporated from and at 212° F. into steam for each pound or gallon of oil burned. In testing, the oil is stated in pounds, but in the practical work the gallon is the more useful unit, since this is the unit used in the engineering log and in the every-day work with oil. Now, different oils have different thermal values, and the oil having the greatest number of B. T. U.'s per gallon will naturally give the greatest evaporation per gallon, but the variation is small.

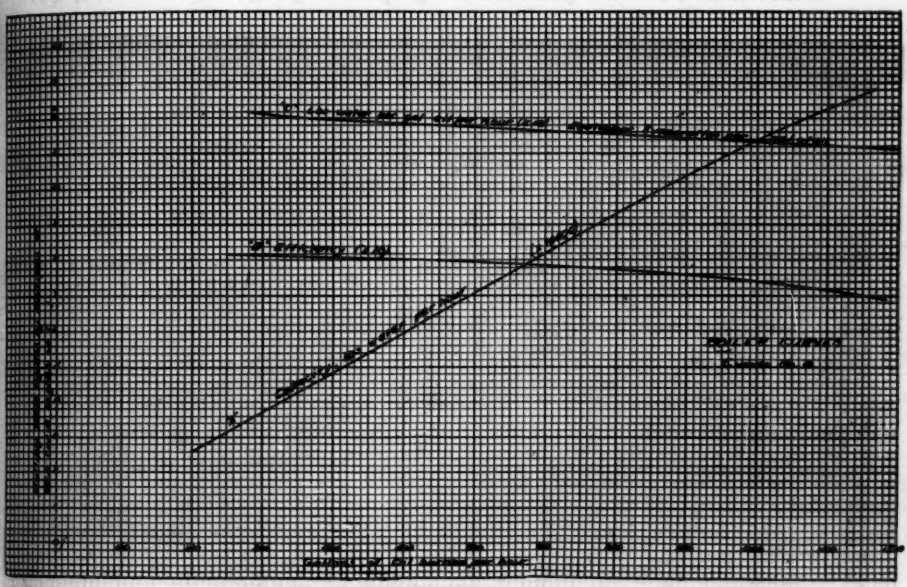
B. T. U.'s per gallon=144,670 average value.
B. T. U.'s per pound= 18,500 average value.

The higher the rate of evaporation, or, in other words, the higher the capacity (output), the lower is the efficiency of a boiler, although for a certain range (from 100 to 200 per cent) above the rated capacity, the efficiency remains practically constant.

The oil consumption or boiler input is stated in terms of the number of gallons of oil burned per knot for a specified speed. When the ship is not under way the oil burned is that required to give the steam for the necessities of that condition. In each case, whether under way or at anchor, the oil burned can be stated in terms of pounds of water evaporated and this apportioned to the various machines which take steam.

III. ACTUAL VALUES OF INTERRELATIONS

Actual values of the foregoing interrelations are given by means of the following curves for each machinery unit: (a) Willan's lines; (b) economy curve; (c) capacity curve; (d) special curves for boilers. These values are mainly from the data supplied by the builders, from the results of tests at the Naval Experimental Station where possible, and from the standard textbooks and handbooks. In all cases the curves are plotted with the load or

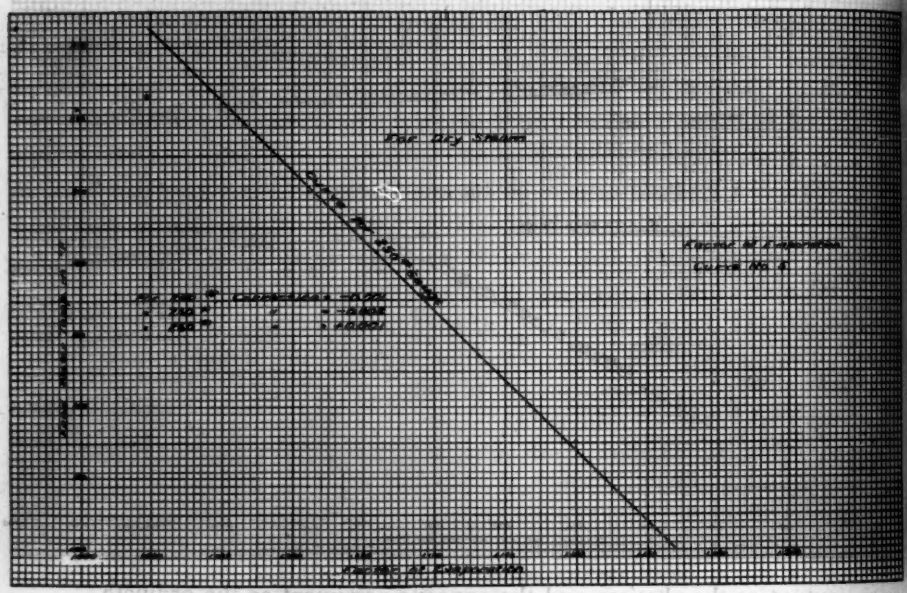


output as the abscissa and the opposite argument as the ordinate. In actual operation these values are rarely obtained, but the effort should be made to approach them.

The following considerations will give some idea of the assumed conditions that also govern these values. The best possible vacuum is maintained for the main turbines; curves of correction for other vacuums are given. All the auxiliary machinery operates against a back pressure, usually of 10 pounds gauge, which increases the steam consumption of each unit about 8 to 15 per cent. The given curves are for the operating conditions:

Boiler Data.—The expenditure of oil for the 24 hours is obtained from the oil meters or by soundings; in the former, it

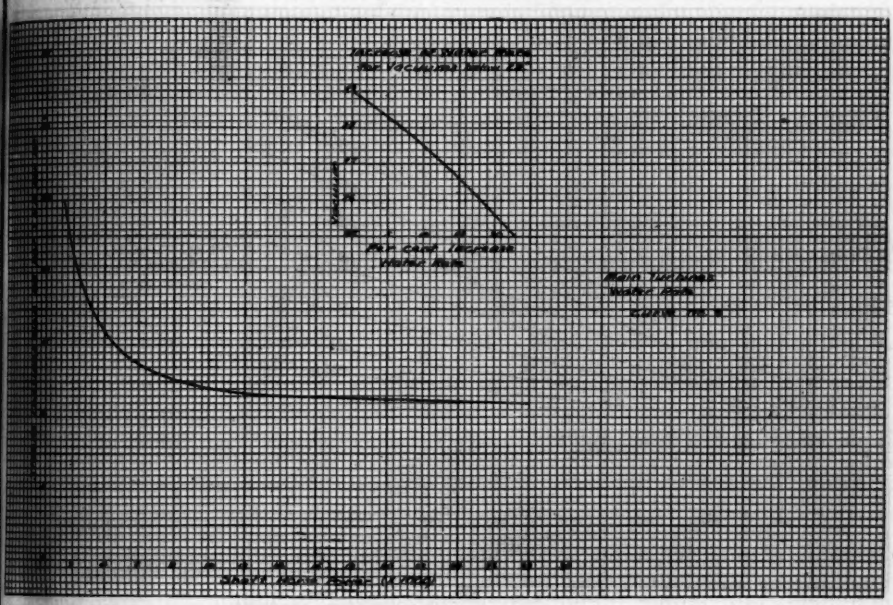
should be corrected for the error of the meter. The hourly expenditure is obtained from the total oil burned. Using the hourly rate, find from curve *C* of the boiler curve sheet (Curve 4) the water evaporated per hour from and at 212° per gallon of oil burned. This quantity times the total number of gallons of oil burned will give the total equivalent evaporation for the 24 hours. Find the factor of evaporation from Curve 5, entering with the feed-water temperature and applying the tabulated correction for other than the boiler pressure of 250 pounds gauge. (The factor



of evaporation $=\frac{H-h}{970.4}$, where H is the total heat in a pound of dry steam at boiler pressure and h is the heat in a pound of feed water above 32° F. This is for dry and saturated steam.) The total equivalent evaporation divided by the factor of evaporation will give the pounds of water actually evaporated under the existing conditions. Example:

Oil for 24 hours	7,800 gallons
Oil for 1 hour	325 gallons
Equivalent evaporation per gallon from curve	120 pounds
Total equivalent evaporation	936,000 pounds
Steam pressure	250 pounds
Feed temperature	230°
Factor of evaporation	1.034
Actual evaporation per hour	905,200 pounds

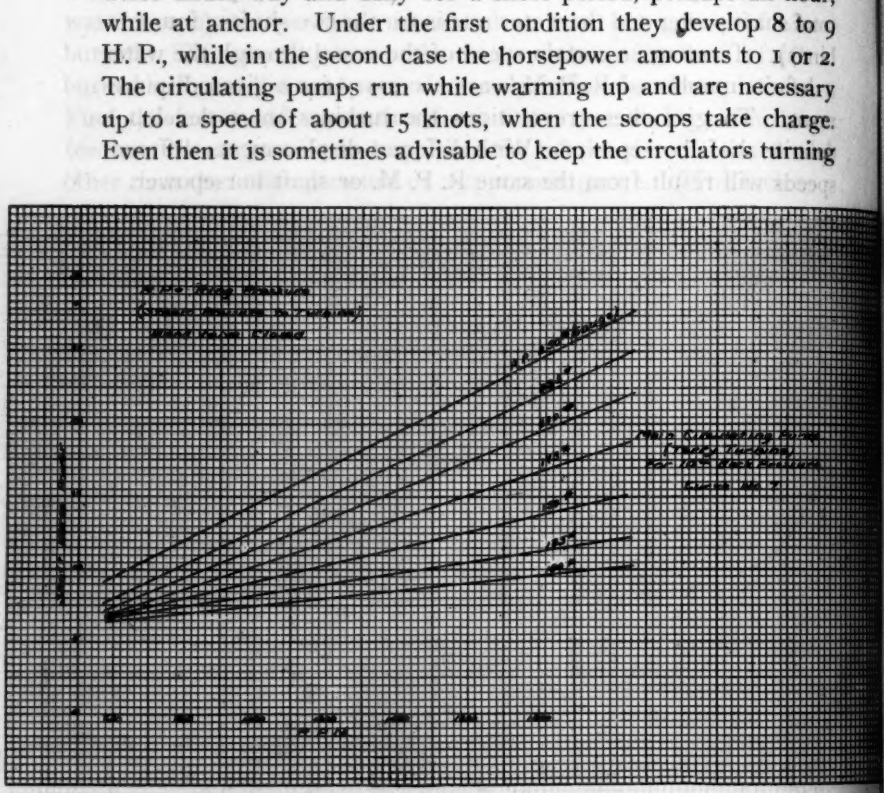
Main Turbines (*Parsons*).—The water-rate curve of the main turbines is given, as its use is more accurate than the use of the Willan's line plotted to the scale of these curves. The power is the total shaft power and the water rate is for the two shafts (four turbines). To secure a certain speed of the vessel through the water a definite number of R. P. M.'s are necessary for a given displacement. To give these revolutions the turbines must develop a definite shaft horsepower. With different displacements different speeds will result from the same R. P. M. or shaft horsepower.



To get the steam used by the turbines enter Curve 1 with the R. P. M. and find the S. H. P.; entering Curve 6 find the water rate for this developed S. H. P. The total S. H. P. multiplied by the water rate will give the total pounds of steam used per hour by the turbines. There are losses of steam through the glands, but with the "feather of steam" called for, instead of the "Channel Fog Bank" sometimes seen, this loss will be relatively small. The increase of the steam rate with vacuums below 29 inches can be found from the insert of Curve 6.

Condensing Plant.—The operation of the main condensers requires the services of one or two main air pumps and two circu-

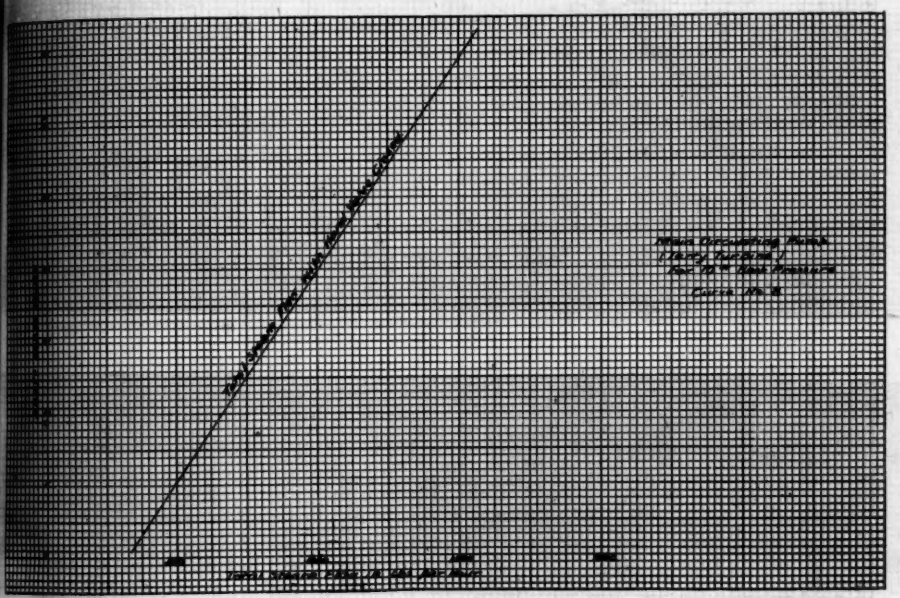
lating pumps if the ship is not making enough way through the water for the scoops to operate. The air pumps run continuously while under way and daily for a short period, perhaps an hour, while at anchor. Under the first condition they develop 8 to 9 H. P., while in the second case the horsepower amounts to 1 or 2. The circulating pumps run while warming up and are necessary up to a speed of about 15 knots, when the scoops take charge. Even then it is sometimes advisable to keep the circulators turning



over. While turning over at about 400 R. P. M. the turbine develops about 5 to 6 B. H. P. and when actually working, at around 1500 R. P. M., about 15 to 16 B. H. P. are developed when the water has free flow through the condensers. In both cases the actual strokes or revolutions should be used in entering the curves to get the steam consumption.

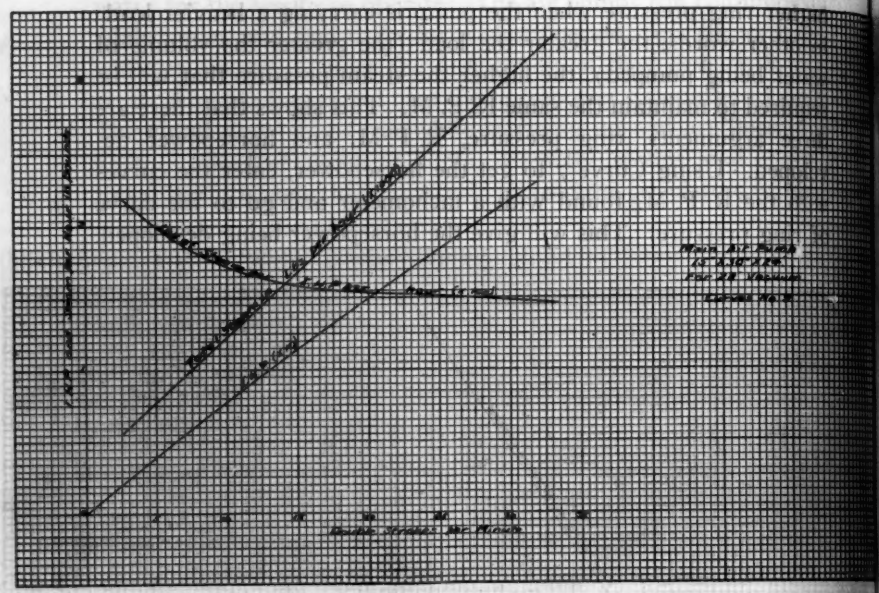
Since the circulator is a centrifugal pump, the power developed cannot be taken directly from the R. P. M. The pumps can be driven at a certain number of R. P. M. by a low "ring pressure" (or the pressure of the steam to the pump turbines) when lightly loaded, but the same number of R. P. M. can be obtained with a

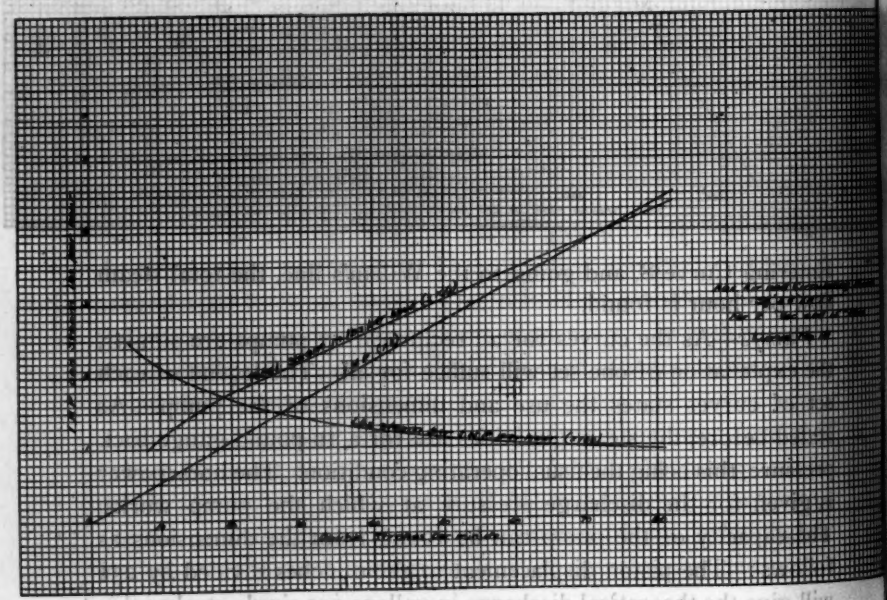
higher ring pressure when the pump is carrying a heavier load; in other words, the greater the load (the greater the volume of water being pumped), the higher the steam pressure that will be required to maintain the same R. P. M. This shows that there are three arguments, ring pressure, R. P. M. and horsepower developed. Using Curve 7 to get the horsepower, enter the curves with the R. P. M. found with a tachometer and go to the curve of ring pressure. This will give the horsepower being developed.

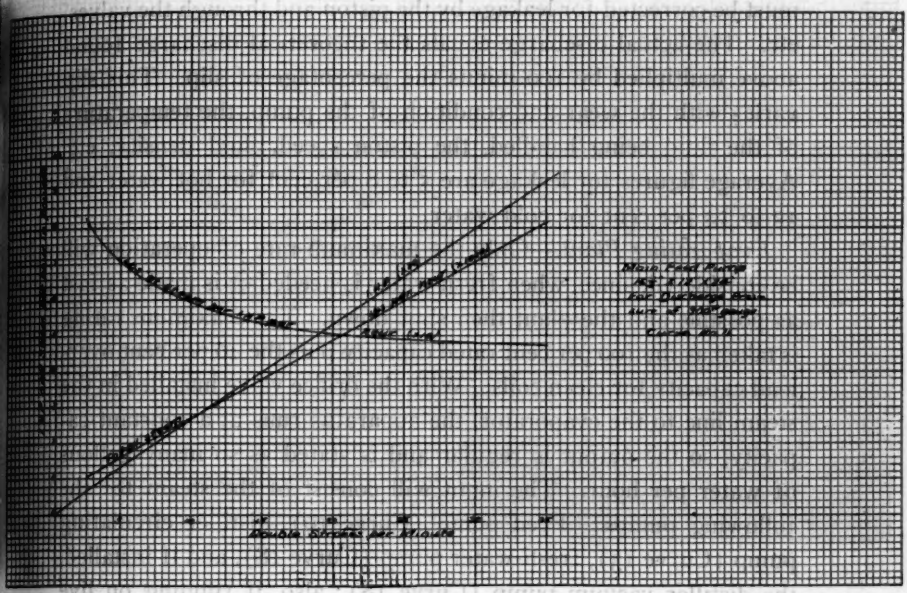


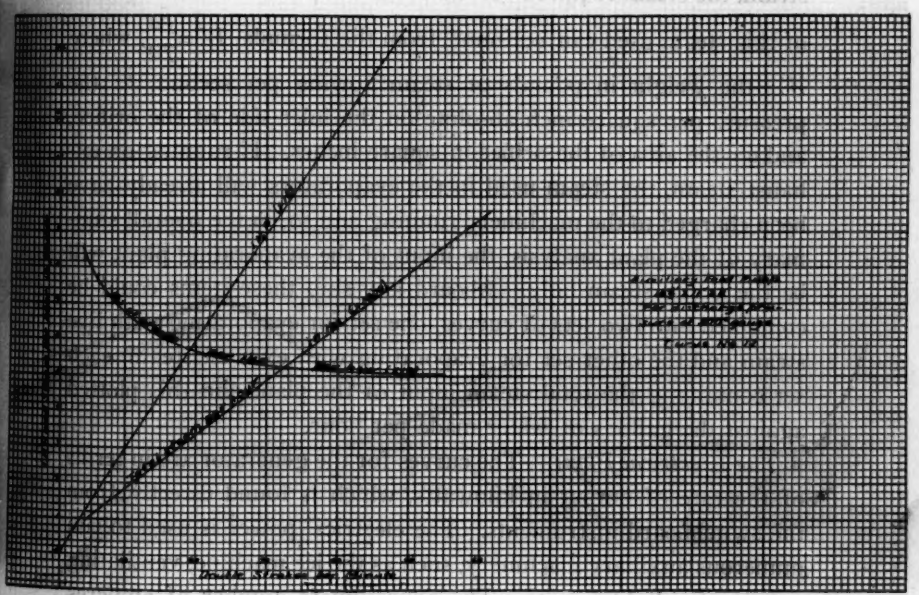
Entering Curve 8, and going to the Willan's line, the total steam flow per hour is found.

Pumps—As the curves for all reciprocating pumps are similar, the explanation of one set will suffice for all. The legend of each set of curves states the use and dimensions of the pump. As stated before, the steam quantities are for a 10-pound gauge back pressure, this being the usual operating condition. The horsepower is given for the discharge pressure at which the pump works. The capacity of the pump can be found from the dimensions as follows: The piston displacement in cubic inches divided by 231 will give the theoretical discharge in gallons per single stroke; this





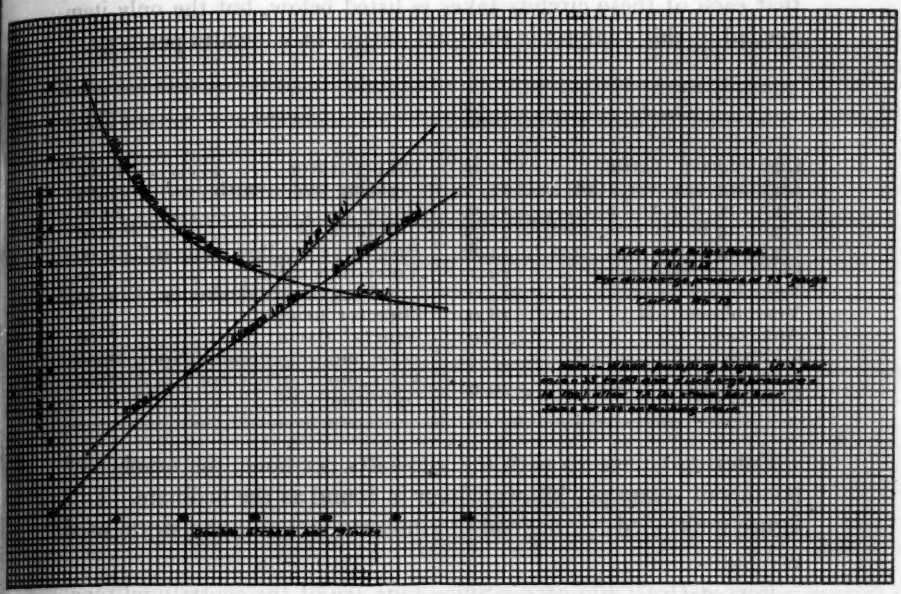


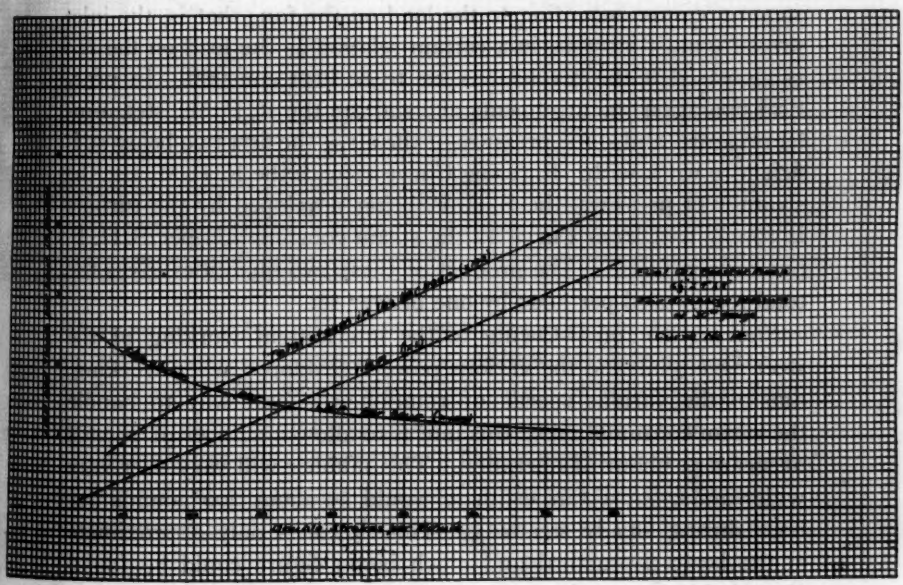


must be corrected for leakage by the piston and through the valves, etc. The actual discharge equals the theoretical discharge found above multiplied by 100 minus the percentage of slip. This slip varies with the wear and condition of the pump, the temperature of the fluid being handled, the piston speed, fluid density, etc. Average figures for leakage are 5 to 8 per cent for hot water and 12 to 14 per cent for cold water.

Evaporating Plant.—Only the maximum rate of operation will be considered, since, when fresh water is needed, it is made as fast as possible and the plant then shut down. The maximum rating is taken as the 100 per cent rated capacity plus the 40 per cent overload capacity for clean coils. With the orifice valve installed in the steam line to the evaporator, the apparatus runs at a constant capacity, so the output is regular and is stated as so many gallons of water per hour. The input will consist of the steam for the following pumps: Feed pump (Curve 19), distiller circulating pump (Curve 13), fresh-water pump (Curve 18), and if installed, the distiller vacuum pump (Curve 18); also, if running on live steam, the steam required for the actual evaporation. The amount of this steam used can be found from the formula, $W=\frac{pa}{70}$, where W = the weight in pounds of steam flowing per second, p = the pressure per square inch absolute on the inlet side of the orifice, and a = the area of the orifice in square inches. If running on exhaust steam, the steam used in the evaporators will already have been charged to the machinery running and so, in the overall summary of the plant analysis, the input of the evaporating plant will be the pump steam only. Aboard any ship these items could be combined into two sets of curves, one set for evaporating with live steam and the other set for evaporating with exhaust steam, each set containing the total steam input of the plant and this plotted against the gallons of water made per hour.

The Electrical Plant.—The curves for the generator are in terms of the rate of output in kilowatts, which is found directly from the switchboard instruments. The electrical power is used to run numerous auxiliary machinery, such as the ice machine, ventilating motors, for lighting, etc. The approximate number of amperes





that each of these circuits takes is listed below, but the only item needed in this analysis is the total output in kilowatts per hour.

Circuit	Load amp.	Circuit	Load amp.
Lighting aft—battle	7.65	Oil separator	15.00
Lighting eng. rm. stbd	12.10	Lighting fwd.—battle	53.69
Lighting eng. rm. port	11.00	Radio	80.00
Lighting boiler rms. stbd	11.30	Call bells	1.00
Lighting boiler rms. port	14.88	Broadside "follow pointer"	4.00
Lighting aft—general	19.25	Voice-tube calls	1.00
Vent. blower fwd	14.00	Loud-speaking telephones	1.00
Vent. blower aft	18.00	Director firing	3.00
Aux. radio rm	5.00	General alarm	6.00
Lighting fwd.—general	37.26	125-v. motor generator No. 1	25.00
Machine shop Refrig. machine	46.00	125-v. motor generator No. 2	25.00
		Gyro-compass	?

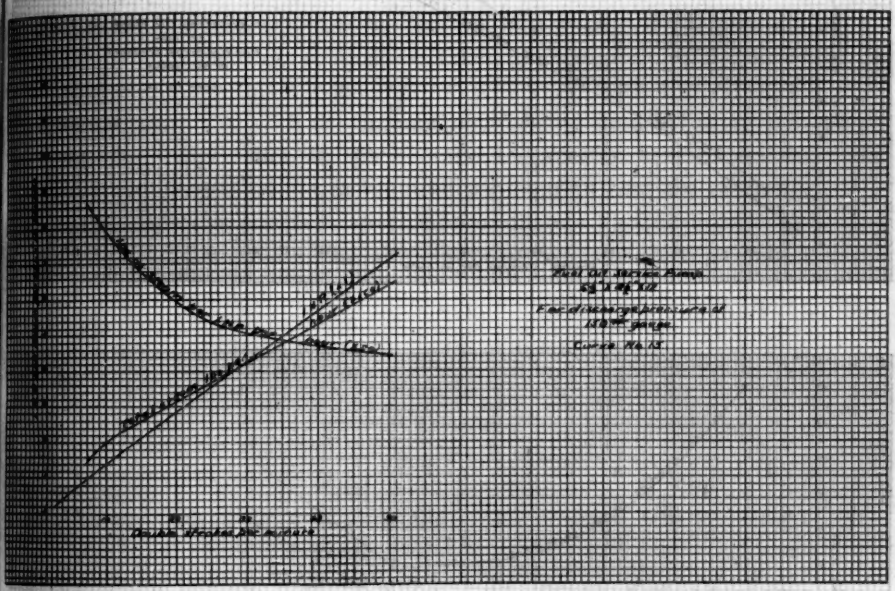
Entering Curve 20 with the kilowatts per hour, the number of pounds of steam per kilowatt hour is found as the ordinate. This figure multiplied by the load in kilowatts will give the steam used per hour.

Forced-Draft Blowers.—Since fans are of the centrifugal type, there can be different numbers of R. P. M. for a constant-inlet steam pressure according to the load on the fan; that is, the inlet pressure must increase in a certain relation as the load on the fan is increased if the revolutions are to be kept constant. In practical operation the arguments at hand are the R. P. M., steam-inlet pressure, and static pressure of the air,—the first two being sufficient to work with. Entering Curve 21 with the R. P. M. and the steam-inlet pressure, the S. H. P. being developed by the turbine is found, and from Curve 22 the steam consumption per S. H. P. per hour is found. The product of these two quantities gives the total steam used per hour by one blower set.

Steering Engine.—Owing to the intermittent working of the steering engine and the various powers developed when working, due to the various speeds of rotation, the best way to handle the steam consumption of this unit is to allow a number of pounds of steam per hour of operation. This number will vary over very wide limits, but a fair estimate would be about 200 pounds per hour during steady steaming. This figure is only approximate at the best; a practical and much better figure could be found aboard ship by running a simple test on the engine itself.

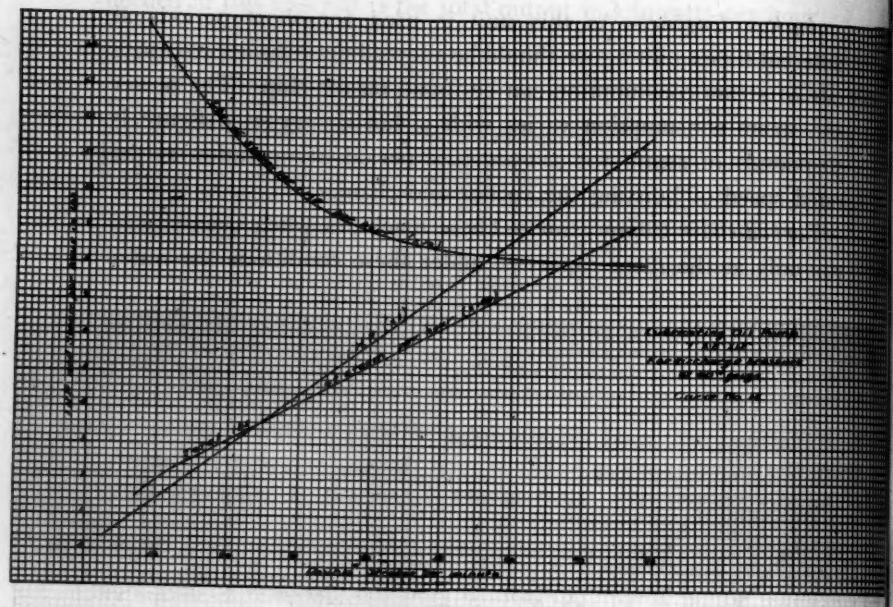
Anchor Engine.—As this unit is used for short periods at different times a set figure should be adopted until the approximate rate of steam consumption can be found on the ship. The power and steam consumption varies widely, but a suggested figure is 30 pounds of steam for a 15-minute period of operation at the rated speed of hoisting the anchor and chain.

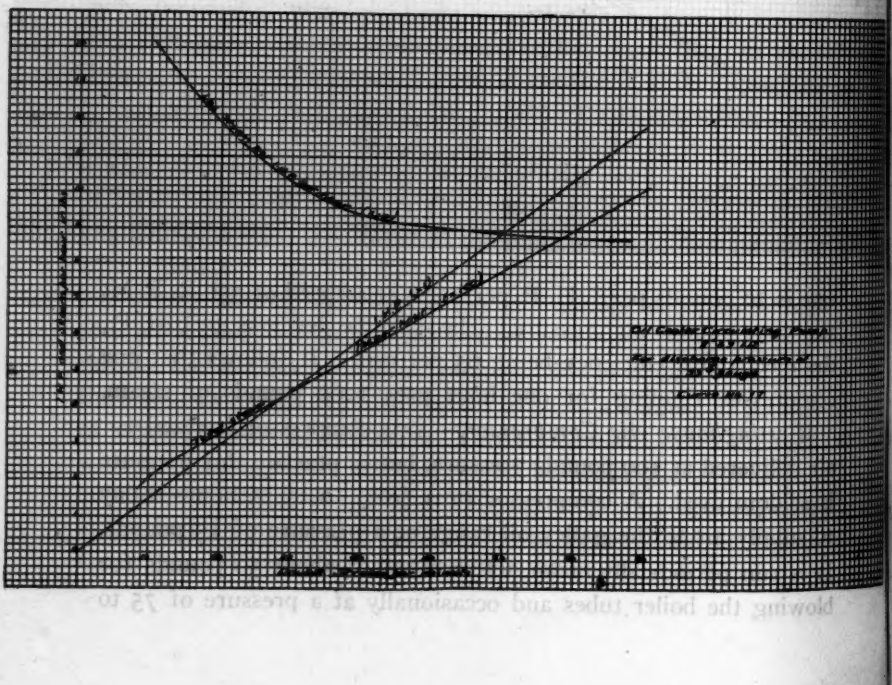
Torpedo Air Compressor.—These machines when used should run only at the rated capacity; under these conditions the water



rate is 30 pounds per I. H. P. per hour, at a speed of 350 R. P. M. and 3000 pounds air pressure. The machine develops 42 I. H. P., the mechanical efficiency being 65 per cent. It follows that one compressor running for one hour uses 1260 pounds of steam.

Westinghouse Air Compressor.—This compressor is rated for air delivered at 100 pounds pressure, but in practice this pressure is seldom used. A compressor runs from 12 to 13 hours a day to supply air to the galley oil range at a pressure of 15 pounds. It is run periodically at an air pressure of about 50 pounds for blowing the boiler tubes and occasionally at a pressure of 75 to





80 pounds for pneumatic tools. Under the above conditions the following steam consumptions obtain:

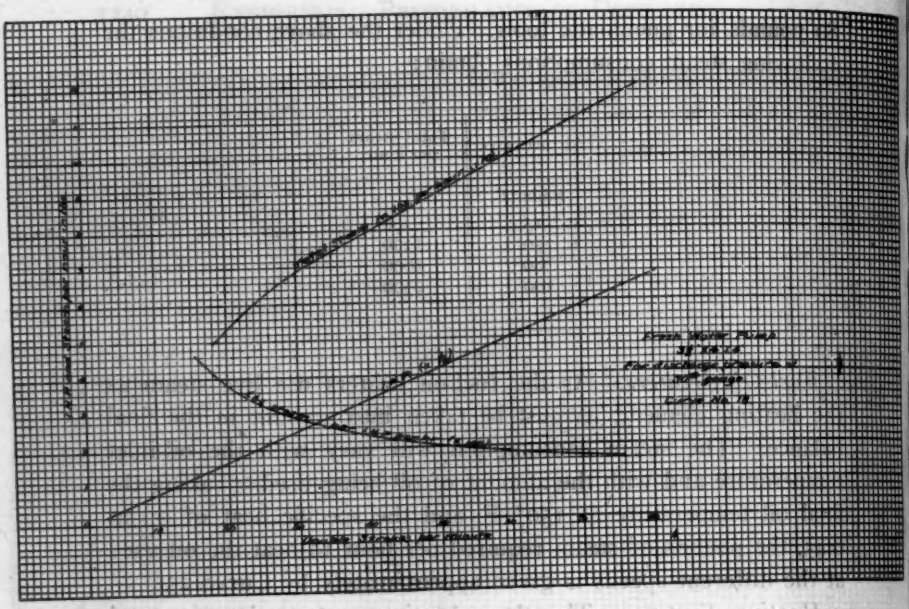
Air pressure	Total steam per hour
Pounds	
15	400
50	1200
80	1600
100	2500

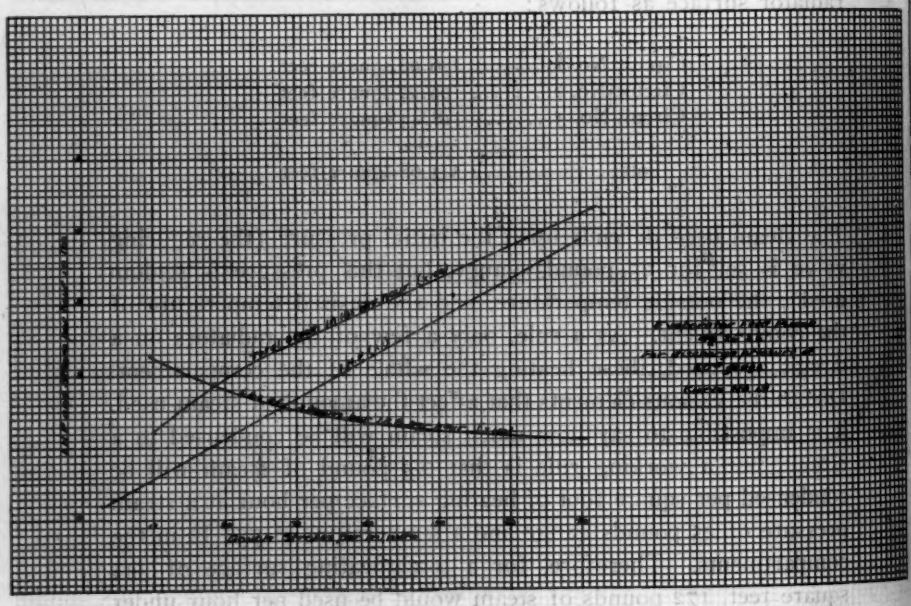
Fuel-Oil Heaters.—As the fuel-oil heaters use live steam as the heating element, it must be taken into account in the final balance. The steam consumption will vary with the oil-inlet temperature and with the amount of oil being used. Taking the final oil temperature at 150° F. and the specific heat of oil at 0.45, the pounds of steam required per hour to heat the oil used at the different speeds is given approximately by Curve 23.

Heating Systems.—The three heating systems have a total radiator surface as follows:

Circuit No. 1.....	126.02 square feet
Circuit No. 2.....	99.22 square feet
Circuit No. 3.....	118.44 square feet
Total.....	343.68 square feet

The steam used depends upon the initial pressure (the reducing valve is set for 25 pounds gauge, but this pressure is seldom used), the outside temperature, and the desired temperature of the compartment. As a rule, only a few of the radiators on a circuit are used, these heating the whole of the compartment. Due to the various elements that affect the amount of steam used, it is impossible to say how much steam will be condensed in a circuit, but a working rule is that 0.5 pound of steam will be condensed per square foot of heating surface per hour at a steam pressure of 25 pounds gauge and a temperature of 75° F. in the compartments. Therefore, for a total heating surface of 344 square feet, 172 pounds of steam would be used per hour under the above conditions.





Galley, Baths and Pantry.—The steam used in the galley, in heating wash water, in the pantry, and for heating the baths amounts to an appreciable figure in 24 hours. As an estimated figure to work with, 25 to 75 pounds of steam should be allowed per day.

IV. EXAMPLES OF ANALYSIS

Two examples of the application of the analysis are given below, the first for the vessel under way and the second for the vessel at anchor. In each example the first part consists of extracts of data that are available daily aboard ship, that is, without special data being taken. The second part consists of these data transferred to a form of analysis.

EXAMPLE 1.—Under way.

Extracts of data: Speed = 18 knots; R. P. M. = 206; displacement = 1400 tons; (standard R. P. M. = 187 for standard displacement of 1160 tons); feed-water temperature = 220° F.; oil for 24 hours = 15,000 gallons; water distilled = 10,500 gallons.

Auxiliaries	No.	Strokes or R. P. M.	Hours
F. D. blower	1	1050	24
Flushing pump	1	20	24
F. and B. pump	1	20	2
Oil-service pump	1	10	24
Oil-booster pump	1	7	24
Main feed pump	1	8	24
Lubricating pump	2	17	24
Main air pump	2	8	24
Evaporator feed pump	1	12	24
Distiller cir. pump	1	10	24
Fresh-water pump	1	45	24
Evaporators	..	Double effect.	24
West. air compressor	...	For galley.	12
Generator	1	258 K.W.H.	24.5
Steering engine	..	.....	24

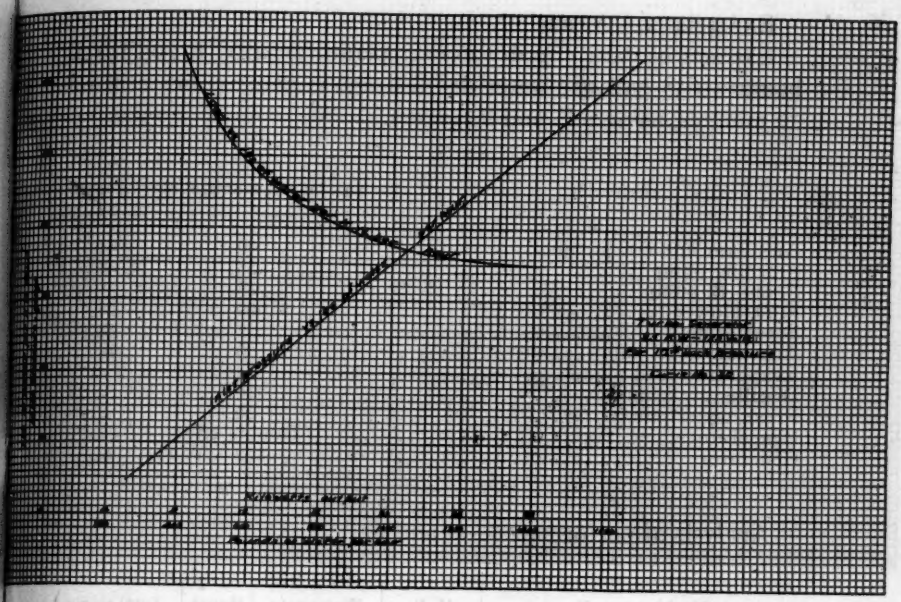
Analysis of performance—under way.

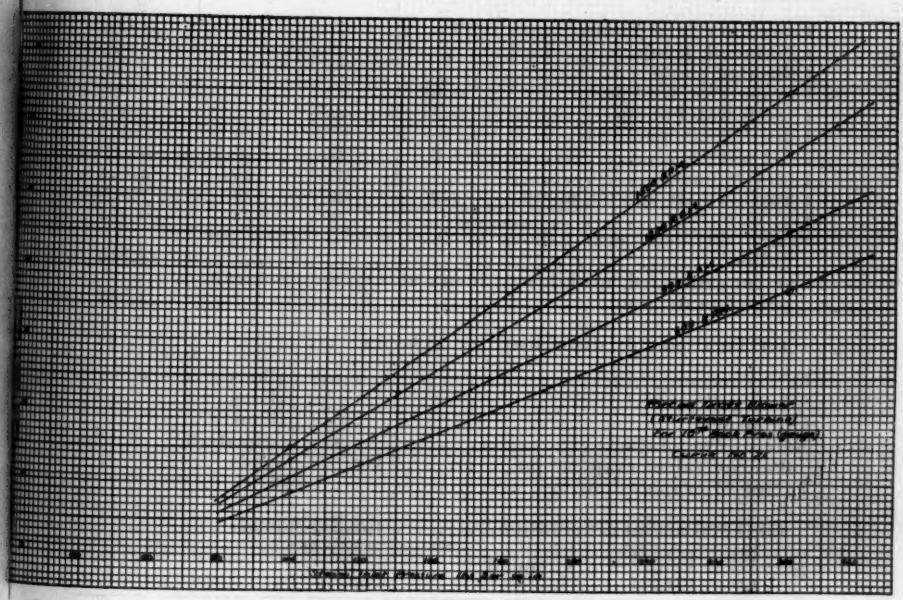
Machinery unit	H. P.	Water rate	Hours	Total steam
Main turbines	2700	18.0	24	1,166,400
1 main feed pump	2.1	63.5	24	32,004
1 F. and B. pump	..	(75)	2	150
1 flushing pump	..	(75)	24	1,800
1 evaporator feed pump	0.7	217.5	24	3,654
1 fresh-water pump	0.38	220	24	581
1 distiller cir. pump	1.9	101	24	4,606
1 lubricating oil pump	2.4	124	24	6,147
1 booster pump	0.3	240	24	1,728
1 service pump	1.4	158	24	5,308
2 main air pumps	6.3	180	24	53,568
1 air compressor	..	(400)	12	4,800
1 F. D. blower	51	87	24	212,876
1 steering engine	..	(200)	24	4,900
Water distilled, 10,500 gallons at 6.27 pounds steam per gallon				68,835
Current generated, 258 kilowatt-hours at 105.5 pounds steam per kilowatt-hour				26,976
(1) Total pounds steam used for 24 hours				1,591,530

Oil by account	15,000 gallons
Oil to galley	50 gallons
Oil burned	14,950 gallons
Rate of evaporation	118 pounds per gallon
Total equivalent evaporation	1,154,100 pounds
Factor of evaporation	1.045

(2) Total actual evaporation ..... 1,678,564 pounds

$$E = \frac{(1)}{(2)} = \frac{1,591,530}{1,678,564} = 0.95 \text{ pound.}$$





EXAMPLE 2.—At anchor.

Extracts of data: Feed-water temperature = 210° F.; oil for 24 hours = 1658 gallons; water distilled = 3000 gallons; fire drill for 12 minutes, using 2 F. and B. pumps.

Auxiliaries	No.	Strokes or R. P. M.	Hours
Auxiliary and cir. pump	1	40	24
Flushing pump	1	35	24
F. and B. pump	1	35	1
F. D. blower	1	1,000	24
Service pump	1	7	24
Auxiliary feed pump	1	6	24
Evaporator feed pump	1	12	4.7
Distiller cir. pump	1	10	4.7
Fresh-water pump	1	40	4.7
Evaporators	..	Double effect.	4.7
Generator	1	192 K.W.H.	24.5

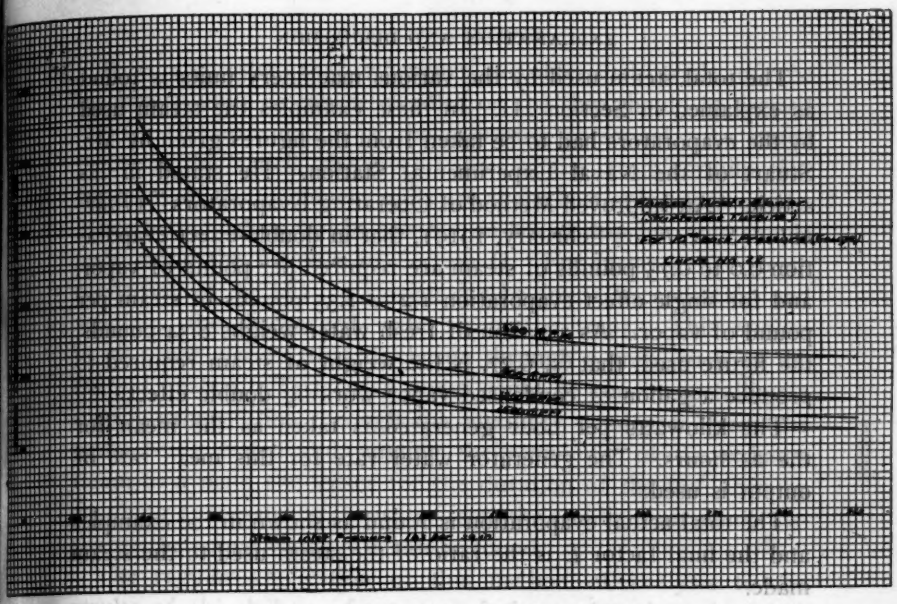
Analysis of performance—at anchor.

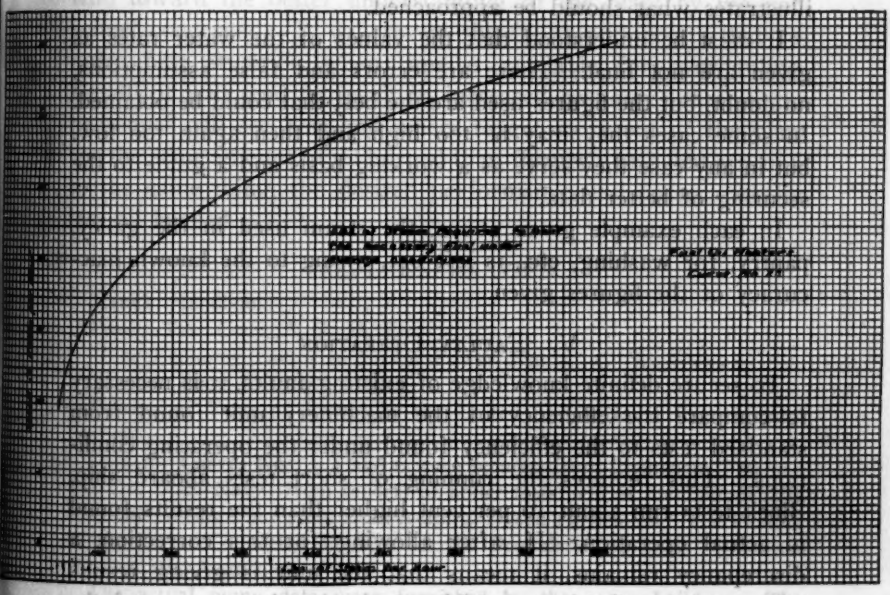
Machinery unit	H. P.	Water rate	Hours	Total steam
1 auxiliary feed pump	18	78	24	33,696
1 F. and B. pump	..	(75)	1	75
1 flushing pump	..	(75)	24	1,800
1 evaporator feed pump	0.65	215	4.7	657
1 fresh-water pump	0.34	240	4.7	384
1 distiller cir. pump	..	(75)	4.7	353
2 fire pumps	7.8	62	0.2	97
1 service pump	1	176	24	4,224
1 auxiliary air and cir. pump	2.25	130	24	7,020
1 F. D. blower	27	93	24	60,264
Water distilled, 3000 gallons at 6.27 pounds steam per gallon				18,810
Current generated, 192 kilowatt hours at 129 pounds steam per kilowatt hour				24,768
(1) Total pounds steam used for 24 hours				152,148

Oil by account	1,658 gallons
Oil to galley	50 gallons
Oil burned	1,608 gallons
Rate of evaporation	126 (estimated)
Total equivalent evaporation	202,608 pounds
Factor of evaporation	1.056

(2) Total actual evaporation..... 192,811 pounds

$$E = \frac{(1)}{(2)} = \frac{152,148}{192,811} = 0.79 \text{ pound.}$$





EXPLANATION AND DISCUSSION

The total steam used by the various machinery units is found as explained in Section III. In these examples the steam used by the evaporators had to be taken from the figures given by Mr. Stuart of the Naval Experimental Station. He stated in his article, "An Improved Method of Operating Evaporators" (*Journal A. S. N. E.* of February, 1919), that in double-effect evaporation 0.6 to 0.75 pounds of steam are required per pound of vapor, and for single-effect evaporation 1.2 to 1.35 pounds of steam per pound of vapor. As a gallon of fresh water weighs 8.34 pounds, the figure used, that is, 6.27, is the weight of steam required to produce a gallon of condensed vapor working double effect.

The kilowatts per hour generated is taken as the mean for the 24 hours. The generator water rate for this mean rate of output is used.

The total actual evaporation is found as shown in the examples and the final factor E is the ratio of the steam used to the steam made.

The value of E for the first example may be too high, but it illustrates what should be approached.

It must be understood that the values of the water rates as given are not final. There are errors and false assumptions, no doubt, but the figures used are the best that could be obtained. In some cases they may be too high and then again too low, but in any case they serve as a working basis and a guide to the securing of better data.

In each example given above, the steam used in the galley, pantry, for washing, etc., is left out, owing to the known inaccuracy of the figures given.

V. FAULTY OPERATION

To secure definite knowledge of existing faults, it is necessary to compare the efficiency of the machinery unit found from standard tests to the efficiency found under the operating conditions. This requires the running of short tests aboard ship. Block tests run about 10 per cent higher than the results found in actual operation. If, after allowing for this correction, a discrepancy remains, it means that the unit is giving results that are below its best possible results by the amount of the difference between these two efficiencies.

VI. SUGGESTIONS

It is suggested that whenever possible such trials of the machinery units as can be handled on the ship should be carried out for the information of the operating personnel. As stated before in this article, the given values of the steam consumption for many of the machinery units are at the best only approximate. Much better values can be secured on board ship by some simple tests, using the formulæ of Section II. For instance, the steam condensed in the heating system can be found by collecting and weighing the discharged water from the traps. This applies to all other circuits that discharge through a trap, such as the fuel-oil heaters. Tests of a pump could be run by installing a special exhaust line through the auxiliary condenser from the pump being tested and running the remainder of the exhaust steam to a main condenser for the duration of the test, then by weighing or measuring the water from the auxiliary air-pump discharge the actual water rate can be found.

The regular application of this method of analysis to the results of the daily performance of the engineering plant will tend toward the better understanding of the plant by the personnel concerned. It will reveal the faults and points that require first attention when time is available for overhauling. Finally it will tend to result in increased economy; that is, the personnel will see how and where to get more out of the plant for the same amount of oil burned than formerly or, what amounts to the same thing, the desired performance will be secured for less oil burned.

REFERENCES USED

Mark's Handbook.

Power Test Code, A. S. M. E.

"The Economy Factor in Steam Power Plants," G. W. Hawkins.

"Power Plant Testing," Moyer.

Reports of Tests of Pumps by the United States Naval Experimental Station.

Data for Curves Nos. 3, 4 and 6 were secured from Lieutenant Fineman (C. C.), U. S. Navy; from reports of boiler tests held at the Philadelphia Fuel Oil Testing Plant; and from Admiral Dyson's article on "The Passing of the Direct Connected Turbine for the Propulsion of Ships." (*Journal A. S. N. E.*, August, 1919).

The actual pump data were furnished by the pump builders. The steaming data were checked with data secured from the U. S. S. *McCalla*.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

OUR FIRST NATIONAL SHIPPING POLICY

By JAMES P. BAXTER, 3D

A more cogent presentation of the case for government owned and operated merchant ships than Lieut. Commander K. C. McIntosh's brilliant article, "U. S. C. N.," in the October PROCEEDINGS, would be hard to imagine. Yet in the present temper of the press, public and Congress, all arguments for government ownership or operation of anything whatsoever, seem likely to fall on deaf ears. Confronted with the staggering deficits from railway operation, Congress has refused a longer trial of government-operated railroads, with the approval of the great majority of the press. Our war experience has given added strength to the American national sentiment for private ownership and private operation. With a score of yarns on his tongue about extravagance and waste in the construction of some cantonment, hospital, or shipyard, the average business man is perhaps more ready to draw inferences against government ownership than to draw the inescapable conclusion that twelfth-hour preparation means, inevitably, great cost in money and lives.

Whether the transition of our splendid new merchant fleet from public to private hands be made "as soon as practicable"—as provided by the Greene bill, which the House of Representatives passed by a vote of 240 to 8—or whether it be spread over a long period of years, the protection of American shipping against ruinous foreign competition is imperative. To expect private shipowners, handicapped by American conditions and denied protection, to compete successfully with foreigners enjoying direct or indirect government aid, is to disregard both the history of American navigation and the promptings of common sense.

Our first national shipping policy, steering clear of the rocks of ship subsidy, employed the Congressional power to regulate com-

merce so as to foster American shipping. This brilliantly successful policy ushered in the heyday of American navigation, when our ships "whitened every sea." A brief review of it will throw light on the provision of Senator Jones's pending bill which directs the President "without delay to take whatever steps are necessary to abrogate the provisions of all treaties of commerce that restrict our right to impose discriminating duties on imports carried in American ships."

Professor William Hill's admirable monograph, "The First Stages of the Tariff Policy of the United States,"[1] shows that protection to American shipping interests dates back to earliest colonial times. Previous to the Revolution, New Jersey, Delaware and Georgia were the only colonies which did not levy tonnage duties. Although these were clearly for revenue, "they were so framed that the colonial shipping interest secured a good degree of protection. In fact, there was no colony which did not exempt at least its own shipping from tonnage dues. The northern colonies all had reciprocity arrangements, by virtue of which the vessels of each entered the ports of the others free."[2] At first the colonists taxed British ships, but they were forced to desist when the merchants complained to the Crown.

As coin was exceedingly scarce in these early days, and munitions of war were much needed for conflicts with the French, Indians and Spanish, the impost on shipping, which was the earliest of any duties imposed by a colonial assembly, was at first made payable in powder. The Virginia act of 1632, whose rates were about the average imposed in the colonies, taxed each ship one hundred pounds of powder and ten iron shot for every one hundred tons burden.[3] "After money became more plentiful, the powder duties were commuted into cash payments ranging from sixpence to one or two shillings per ton, according to the amount of depreciation in the provincial currency."[4] Most colonies continued these duties until, in 1789, the regulation of commerce passed from the hands of the states to those of the Federal Government.

[1] American Economic Association's *Publications*, viii, no. 6, 1893.
[2] *Ibid.*, 20.
[3] *Ibid.*, 18.
[4] *Ibid.*, 19.

There were early examples of the policy, later famous, of attempting to coerce another government by commercial restrictions. By a retaliatory act passed in 1649, Massachusetts compelled Connecticut to repeal obnoxious tolls on goods carried down the river from Springfield. Virginia also sought to force Maryland to abandon tonnage dues on Virginia vessels.[5]

American navigation suffered severely under the policy of commercial restrictions adopted by the First Continental Congress on October 20, 1774. To force a change in British policy by pressure on her commercial interests, as at the time of the Stamp Act, the patriot "associators" bound themselves to enforce a stringent non-importation, non-exportation and non-consumption agreement, which soon laid bare the shelves of the importers and retailers. Hostilities told heavily on American shipping. In the years from 1776 to 1779, British privateers and ships of the squadrons of Howe and Gambier, took 570 vessels.[6] As the war progressed, however, trade increased. Yankee privateers brought in rich cargoes of prize goods, and daring skippers ran the blockade to trade with Holland, France, Spain and the West Indies. "By 1777, the storerooms began to fill up and after that year to the end of the conflict, necessities, luxuries, and even superfluities were abundant . . . . The war brought hardships to the Americans; but these had mostly disappeared by 1779 and the last years had been marked by speculation in business and extravagance in living. In 1783, the New Englanders and the dwellers in the Middle States were enjoying a degree of comfort unknown before 1775."[7] "The breakdown of the Continental currency in 1780 had been followed by an influx of specie which gave America more coin than she had ever before possessed."[8] Large sums of hard money were spent by the British and French fleets and armies, and coin was also imported from Havana and other foreign markets. With the coming of peace and independence, Americans naturally anticipated every blessing: boom times, high prices and expanding trade.

Their disillusionment was bitter. Independence left America outside the pale of Britain's navigation laws. All the profits re-

[5] *Ibid.*, 15.
[6] Channing, *History of the United States*, iii, 404.
[7] *Ibid.*, iii, 388, 389.
[8] Hill, *op. cit.*, 60.

sulting from direct trade with Europe, for which the colonists had long sighed, were outweighed by the losses inflicted by Britain's exclusive system. Her policy, the motives for which Mahan has luminously discussed in the first two chapters of *Sea Power in its Relations to the War of 1812,* gave to America some slight favors in the direct trade between the two countries, but excluded American ships from her West India colonies and from her remaining North American possessions. American salt fish and salted meats, butter and cheese, were shut out of the sugar islands even when carried in British bottoms. William Knox, who drafted the Order in Council of July 2, 1783,[9] boasted that he "carried it thro' against the opposition of Mr. Fox and Mr. Burke, and thereby saved the navigation and maritime importance of this country and strangled in the birth that of the United States."[10] This staggering blow closed a great market to New England fish, and cut off the most lucrative branch of American navigation. Despite some welcome relaxations of the exclusive systems of France and Spain, our shipowners suffered severely until they could develop new outlets for trade in the Baltic, the Mediterranean, and the Far East.

Immediately after the peace, a flood of British manufactures swept in upon the American merchants, swamped our infant industries, and drained our bountiful stock of specie. Professor Hill's figures for the trade with Great Britain in the three years from 1784 to 1786, show an adverse balance of over five million pounds sterling.[11] After a period of overtrading, the year 1785 witnessed severe business depression. With prices falling, manufactures at a standstill, navigation and the fisheries in dire straits, buoyant hope changed to bitter lamentation. Americans who suffered from the shortage of hard money, read with indignation of cargo after cargo of specie bound for England. In the summer of 1786, the bark *Mary Barnard,* freighted with the miscellaneous currency of the day, cleared from Boston for London, with "forty-six thousand one hundred and twenty-five dollars; twelve hundred and twenty-nine joes; one hundred and ten half-joes; eight hundred and six crowns; two thousand and eighty-seven guineas; eighty-five pistoles; two hundred and sixty-four dollars in silver;

[9] Printed in John Adams, *Works,* viii, 97 note.
[10] Channing, iii, 428.
[11] Hill, *op. cit.,* 67 note.

one moidore, and five hundred and fifty-six ounces of gold." [12] The hatred engendered by war was nursed by the conviction that the enemy's commercial policy was designed less to benefit herself than to cripple a rival. Our leading statesmen, who, except Hamilton, had been all free traders, yielded to the logic of events, and led a popular movement for retaliation and protection.

John Adams persistently and vehemently urged an American navigation act. In his letter transmitting to Secretary Livingston the hostile British decree of July 2, 1783, he declared that in protection and retaliation lay America's hope of maritime salvation.[13] To Jefferson he wrote, August 7, 1785: "We must do more than lay on alien duties. We must take measures by which the increase of shipping and seamen will be not only encouraged, but rendered inevitable." [14] In the same month, while arguing for a commercial treaty, he told Pitt that "the more Americans reflected upon the great advantages which they might derive from a navigation act, the more they would become attached to that system." [15] But his persistent efforts, during nearly three years at the Court of St. James, to put our commercial relations with Great Britain on a tolerable footing, came to naught. Jealousy and contempt blocked all negotiation. "Their direct object is not so much the increase of their own wealth, ships, or sailors, as the diminution of ours. A jealousy of our naval power is the true motive, the real passion which actuates them; they consider the United States as their rival, and the most dangerous rival they have in the world." [16] "But if an angel from heaven should declare to this nation [Great Britain], that our States will unite, retaliate, prohibit, or trade with France, they would not believe it. There is not one man in the nation who pretends to believe it; and, if he did, he would be treated with scorn." [17]

Until the impotent government of the Confederation gave place in 1789 to a more perfect Union, the British were safe in their unbelief. As early as 1778, the New Jersey legislature had declared that Congress ought to have the sole and exclusive power

[12] McMaster, *History of the People of the United States*, i, 294.
[13] John Adams, *Works*, viii, 97.
[14] *Ibid.*, 292.
[15] *Ibid.*, 305.
[16] *Ibid.*, 290
[17] *Ibid.*, 390.

of regulating the foreign trade of the states, suggesting at the same time that the customs revenue should be devoted to the creation and maintenance of a federal navy.[18] As this statesmanlike suggestion fell on deaf ears, the regulation of commerce was left in the hands of the thirteen separate State legislatures. The dire straits of American trade after the peace of 1783, however, made a national commercial policy imperative. April 30, 1784, Congress adopted the report of a committee composed of Jefferson, Gerry and three others, and recommended to the States that they amend the Articles of Confederation so as to vest Congress for fifteen years with the power to regulate commerce by a navigation act.[19] To amend the Articles required the unanimous vote of the states. Yet in 1786 it was found that Delaware, South Carolina and Georgia had passed no act upon the subject, and that the legislation of the other states presented a hopeless jumble of amendments, conditions and restrictions.[20] A letter from John Jay, then Secretary for Foreign Affairs, to John Adams, November 1, 1785, illuminates the sources of difficulty. "In a late report I have called the attention of Congress to this serious question, viz., whether the United States should withdraw their attention from the ocean and leave foreigners to fetch and carry for them, or whether it is more their interest to look forward to naval strength and maritime importance, and to take and persevere in the measures proper to attain it . . . . The Eastern and Middle States are generally for the latter system, and though the others do not openly aver their preferring the former, yet they are evidently inclined to it. Hence it is that the most of the leading men in Congress from that quarter [the South] do not only not promote measures for vesting Congress with power to regulate trade, but, as the common phrase is, throw cold water on all such ideas. Having few or no ships of their own, they are averse to such duties on foreign ones as will greatly advance the price of freight; nor do they seem much disposed to sacrifice any present proffer for the sake of their neighbors who have these and wish to have more."[21]

[18] G. T. Curtis, *Constitutional History of the United States*, i, 90.
[19] *Ibid.*, 192.
[20] *Ibid.*, 194.
[21] Jay, *Correspondence and Public Papers*, iii, 175.

The South, however, was by no means solid in opposition to a navigation act. An influential body of leaders, headed by Madison, took up the fight for maritime independence, and frequently, in the next few years, outdistanced even the representatives of New England in zeal for our national shipping. We catch a glimpse of Virginians of the opposite extreme in a letter from Madison to Jefferson, January 22, 1786, describing a recent debate in the State legislature. "The Speaker [Benjamin Harrison], Thurston, and Corbin . . . . were bitter and illiberal against Congress and the Northern States beyond example. Thurston considered it as problematical, whether it would not be better to encourage the British than the Eastern marine. Braxton and Smith were in the same sentiments, but absent at this crisis of the question."[21]

Confronted with the failure to provide for federal regulation of commerce, the states attacked their problems single-handed. New York, in 1784, imposed double duties on goods imported in British vessels, whether brought directly or through other states, thus seeking to compel her neighbors to discriminate against British shipping. New Hampshire levied treble tonnage taxes on foreign ships and double duties on goods brought in them. Rhode Island placed treble duties on goods imported in British bottoms, and in 1786 provided that no American goods should enter the state in British ships. Massachusetts supplemented her rigorous protective tariffs with an extraordinary tonnage duty on foreign vessels. Both Maryland and Virginia taxed British ships one dollar per ton, discriminated in favor of the French and Dutch, and admitted American ships free. These two states and the Carolinas had discriminating tariff duties as well as tonnage taxes. In the same manner Pennsylvania protected American shipping. Her discriminating duties on teas, which were the model for similar provisions in the first national tariff act of 1789, gave the impetus to the direct trade with the Far East, which was such a spectacular feature of early American commerce. The discriminating duties of all the states averaged nearly sixty cents per ton.[22]

[21] Madison, *Writings* (Hunt edition), ii, 218.

[22] For the varied state legislation, see: E. R. Johnson and others, *History of Domestic and Foreign Commerce of the United States*, i, 139, 172; W. W. Bates, *American Navigation*, 37, 47.

But the administrative systems of the states were so lax, their interests so divergent and their jealousies so unrestrained, that the system of state regulation broke down.[34] In Madison's letter to Jefferson, above cited, we read: "The local efforts to counteract the policy of G. B., instead of succeeding, have in every instance recoiled more or less on the states which ventured on the trial . . . . Discord [has been] produced between several States by rival and adverse regulations. The evil had proceeded so far between Connecticut and Massts. that the former laid heavier duties on imports from the latter than from G. B."

This breakdown of state regulation, and lack of power in the federal head, were of the greatest importance in producing the new Constitution and stronger government. During the first debates of the First Congress, Fisher Ames of Massachusetts declared: "I conceive, sir, that the present Constitution was dictated by commercial necessity more than any other cause. The want of an efficient government to secure the manufacturing interests, and to advance our commerce, was long seen by men of judgment, and pointed out by patriots solicitous to promote our general welfare."[35] In his luminous history of our Constitution, George Ticknor Curtis remarked: "Let the reader consider the interests of commerce, in their widest relations with all that they comprehend—the interests of the merchant, the artisan, and the tiller of the soil being alike involved—as the chief purpose of the new government given to this Union; let him contemplate this as the central object around which are arranged almost all the great provisions of the Constitution of the United States . . . . That such a code of civil government should have sprung from the necessities of commerce is surely one of the triumphs of modern civilization."[36]

Sectional interests clashed in the Constitutional Convention. The report of the Committee of Detail, delivered August 6, denied Congress the power to pass a navigation act without the assent of two thirds of the members present in each House, or to prohibit or tax the migration or importation of slaves.[37] When agree-

[34] Channing, *op. cit.*, iii, 466; Curtis, *op. cit.*, i, 195.
[35] *Annals of Congress, 1 Cong.*, 221.
[36] Curtis, *op. cit.*, 515.
[37] Madison, *Journal of the Constitutional Convention, Writings*, iv, 100.

ment on these provisions, both of which were in the Southern interest, seemed impossible, they were referred, on August 22, to a special committee of eleven, appointed to "form a bargain among the Northern and Southern States."[28] The resulting compromise gave Congress the power to pass a navigation act by a bare majority, and provided that: "The Migration or Importation of such Persons as any of the States now existing shall think proper to admit, shall not be prohibited by the Congress prior to the Year one thousand eight hundred and eight, but a Tax or duty may be imposed on such Importation, not exceeding ten dollars for each Person."[29] Elimination of the two-thirds requirement had evoked a sharp debate. Clymer, of Pennsylvania, asserted that the Northern and Middle States would be ruined unless they were given a navigation act. Gouverneur Morris declared that: "Preferences to American ships will multiply them, till they can carry the Southern produce cheaper than it is now carried. A navy was essential to security, particularly of the Southern States, and can only be had by a navigation act encouraging American bottoms and seamen." George Mason, of Virginia, protested. "The Southern States are the *minority* in both Houses. Is it to be expected that they will deliver themselves bound hand and foot to the Eastern States, and enable them to exclaim, in the words of Cromwell on a certain occasion, 'the Lord hath delivered them into our hands'?" Unreconciled to the omission of the two-thirds requirement, and to other provisions, Mason and his colleague, Edmund Randolph, refused to sign the Constitution.

The brilliantly successful system of shipping protection established by the First Congress through the Tariff and Tonnage Acts of July 4 and July 20, 1789,[30] comprised four distinct features: (1) Discriminating tariff duties on teas and other Asiatic goods gave a great stimulus to the direct trade with the Far East. (2) A discount of 10 per cent of the customs duties on all goods imported in American bottoms made our ships the preferred vessels for carrying to the United States, and helped to provide a profitable return cargo for the American shipowner. (3) Tonnage duties on foreign vessels were more than eight times heavier than on American vessels. (4) The coastwise trade was prac-

[28] *Ibid.*, 271-273.

[29] *Ibid.*, 292, 303-306, 326-332, 469, 491.

[30] *Annals of Congress, 1 Cong.*, 2129, 2132.

tically reserved to American bottoms. To round out the system by extending further protection to American shipbuilding, Congress passed our first Registry Act, September 1, 1789.[21]

No sooner had the members of the House of Representatives assembled, taken the oath, and resolved themselves into a Committee of the Whole, than Madison rose to introduce the tariff and tonnage measures.[22] Except for an act to regulate the time and manner of administering certain oaths, they were the first laws on our statute book. For knowledge of the Congressional opinions, we have to rely chiefly on the House debates, because until 1794 the Legislative as well as the Executive proceedings of the Senate took place behind closed doors. During the discussions in the House, were read petitions from the shipwrights of Charleston, Baltimore and Philadelphia, stating their distress and praying for a navigation act.[23] Fitzsimmons, of Pennsylvania, introduced the discriminating duties on teas, remarking that the trade to India, favored by the Pennsylvania state tariff, already "has had a very happy effect in favor of our inhabitants, by reducing commodities brought from thence to one-half of their former price, and yet a sufficient profit is left to enable those concerned to carry it on with advantage."[24] His proposals, which the House adopted after a brief discussion, were much improved by the Senate. Teas paid a low duty if imported direct from the Orient in American bottoms, a medium duty if brought in American ships from Europe, and a high duty if imported in foreign vessels. Other Oriental goods, when brought in foreign ships, were taxed nearly twice as much as if imported in American bottoms. These provisions, in practice, both increased the trade with the Far East and confined it to American vessels.[25] The important clause allowing a drawback of 10 per cent of the duty payable on all goods imported in American bottoms, was suggested by William Smith, a Baltimore merchant, and was carried by a vote of 30 to 16.[26] The tonnage dues were: on American bottoms, six cents per ton; "on all ships or vessels hereafter built in the United States, belonging wholly, or in part, to subjects of foreign Powers,"

[21] *Ibid.*, 2161.
[22] *Ibid.*, 102.
[23] *Ibid.*, 123, 233, 409.
[24] *Ibid.*, 169.
[25] Johnson and others, *op. cit.*, ii, 337.
[26] *Annals of Congress, 1 Cong.*, 343.

thirty cents per ton; on all other ships or vessels, fifty cents per ton.[37] The Senate rejected the provision in the House bill confining by law our coastwise trade to American bottoms; but achieved the same end by a prohibitory tonnage tax. American ships employed in the coasting trade or in the fisheries paid six cents per ton once a year, while every foreign vessel had to pay fifty cents per ton for each entry into an American port.[38]

Opposition to the tonnage duties was confined to Tucker, Burke and Smith of South Carolina, Jackson of Georgia, and Bland of Virginia. Urging low rates, they insisted that the duties would fall on the American producer instead of the foreign consumer. Tucker protested that the tax would be exclusively borne by a few Southern States.[39] Smith declared: "I would as soon be persuaded to throw myself out of a two-story window, as to believe a high tonnage duty was favorable to South Carolina."[40] Burke was sure that Carolinians believed a high tonnage duty a great evil, but later added: "I believe the citizens [of the South] look with indignation at the power which foreigners have over their commerce. So far from being jealous of the Eastern States, they look forward to some future day when their navigation will be secured to that part of the Union."[41]

Fitzsimmons replied that a tonnage duty, in almost every instance, was paid by the consumer. He advocated a navy to safeguard our neutrality. "The United States can have no commerce without a navy . . . . but if we increase our navigation, and add to the number of our seamen, we shall become respectable, and may be able to pursue our obvious interest in supplying the parties engaged [in war] with the superabundance of our soil, and enable us to stipulate for reciprocal advantages in the West India commerce. If we do not now, while we have time, improve our situation, two or three British frigates may prevent us from gathering these benefits [of neutral trade] hereafter."[42]

Madison led the protectionists with several brilliant speeches. He declared that protection of our shipping would benefit our farmers. "By encouraging the means of transporting our productions with facility, we encourage the raising them."[43] "If it is expedient for America to have vessels employed in commerce at

[37] *Ibid.*, 2132. [38] *Ibid.*, 290, 608, 2132. [39] *Ibid.*, 179. [40] *Ibid.*, 286.
[41] *Ibid.*, 181, 256. [42] *Ibid.*, 241, 278. [43] *Ibid.*, 112.

all, it will be proper that she have enough to answer all the purposes intended; to form a school for seamen, to lay the foundation of a navy, and to be able to support itself against the interference of foreigners . . . . I consider that an acquisition of maritime strength is essential to this country; if ever we are so unfortunate as to be engaged in war, what but this can defend our towns and cities upon the sea-coast? Or what but this can enable us to repel an invading enemy?"[44] "The arguments offered against the measure are founded on a maxim of impolicy. It is stated, that . . . . we ought not to enter into regulations that will increase the price of freight. The plain meaning of which I take to be, let us employ those vessels that will do our business cheapest . . . . I admit, that laying fifty cents on foreign vessels, and but six on our own, is a regulation by which the owners of American shipping will put a considerable part of the difference into their pockets. This, sir, I consider as a sacrifice of interest to policy; the sacrifice is but small, but I should not contend for it, if we did not stand in need of maritime improvements . . . . But we have maritime dangers to guard against, and we can be secured from them no other way than by having a navy and seamen of our own; these can only be obtained by giving a preference . . . . This tax, therefore, may prevent the horror of a war, and secure to us that respect and attention which we merit."[45]

The storm center of debate was Madison's proposal to levy on ships of nations that had formed commercial treaties with us—France, Holland, Sweden and Prussia—a tonnage duty lower than that on ships of Great Britain and other nations not in treaty. He urged that popular sentiment strongly favored a discrimination; that France, our ally, should be favored; that to put Great Britain at once on the footing of the most favored nation was highly impolitic. He declared that as long as we repaid Britain's ill treatment by tamely permitting her to enjoy on her own harsh terms the bulk of our trade, we could not expect her to relax her hostile restrictions; that "If we give everything equally to those who have or have not formed treaties, surely we do not furnish to them any motive for courting our connexion." He feared no British reprisals, for we could, if necessary, ruin their West India islands by refusing them our foodstuffs.[46]

[44] *Ibid.*, 189. [45] *Ibid.*, 237. [46] *Ibid.*, 181, 204, 237-240.

Opposition to discrimination was skilfully led by Lawrence of New York, supported by Benson of New York, and Sherman and Wadsworth of Connecticut. Lawrence urged that France had done little or nothing for our commerce; that our trade with England, even though restricted, was profitable; and that it would be folly to antagonize her and invite reprisals. Britain could easily ruin us if she chose, for "we are, as it were, the creatures of yesterday, unable to stand such competition."[47] His appeals to prudence, however, availed nothing in the House, which, by a vote of about 40 to 9, agreed to tax vessels of treaty nations thirty cents per ton, as against fifty cents on vessels of nations not in treaty.[48] Madison wrote Jefferson, May 9, that the opposition to discrimination, "tho. patronized by some respectable names is chiefly abetted by the spirit of this City [New York], which is steeped in Anglicism."[49]

The Senate, however, rejected the proposed discrimination, and remained inflexible.[50] Despite Madison's appeals, the House finally yielded, by a vote of 31 to 19.[51] The Senate majority preferred conciliation towards Great Britain,[52] and undoubtedly feared reprisals; but Madison was probably right in his assertion that "A considerable number, both in the Senate and H. of Reps. objected to the measure as defective in energy, rather than as wrong in its principle."[53] While Madison may not have overestimated the dependence of the British sugar islands on American supplies, it seems probable that he failed adequately to gauge the British temper and the dangers of commercial warfare to our empty treasury.[54] The British ministry would have hesitated not a moment to sacrifice the prosperity of colonial planters in order to protect the special privileges of British shipowners.[55]

[47] *Ibid.*, 183-185, 203, 234-236.
[48] *Ibid.*, 290; Madison, *Writings*, v, 361 note.
[49] Madison, *Writings*, v, 355 note.
[50] Fisher Ames, *Works*, i, 57.
[51] *Annals of Congress, 1 Cong.*, 607-610, 615-619.
[52] Washington to G. Morris, Oct. 13, 1789, *American State Papers, Foreign Relations*, i, 122.
[53] Madison, *Writings*, v, 433. See also: *Ibid.*, 415 note; Ames, *Works*, i, 60; *Annals of Congress, 1 Cong.*, 46, 57, 588-592, 608-610, 615-619; Schouler, *History of the United States*, i, 102.
[54] Johnson and others, *op. cit.*, ii, 7.
[55] Mahan, *Sea Power in its Relation to the War of 1812*, i, chs. i, ii.

As for America, nearly two-thirds of our foreign trade[46] was with Great Britain; on this trade depended our national revenue; and on the basis of that revenue Hamilton was about to erect a splendid structure of national credit, the salvation of the Republic. Fisher Ames wrote to his friend Minot: "The Senate, God bless them, as if designated by Providence to keep rash and frolicsome brats out of the fire, have demolished the absurd, impolitic, mad discrimination of foreigners in alliance from other foreigners."[47]

Of the effects of our first national shipping policy, Adam Seybert, a contemporary writer, declared: "Our discriminations operated powerfully in favor of our shipping . . . . All foreign nations were affected by the system we had adopted; it seemed to operate like magic in favor of ship-owners in the United States."[48] Mahan states that "After one year of the discriminating tonnage dues laid by the national Congress, the American tonnage entering home ports from Great Britain had risen, from the 26,564 average of the three years, 1787 to 1789, ascertained by the British committee, to 43,580."[49] Dr. G. G. Huebner, of the University of Pennsylvania, has compiled a table, which shows that the proportion in value of our foreign trade carried in American bottoms, rose from 40.5 per cent in 1790 to 79.5 per cent in 1793, and 90 per cent two years later; but he states that the returns for 1789 to 1793 were incomplete.[50] American tonnage in foreign trade entering home ports, rose from 354,767 in 1790 to 414,679 in 1792, while British tonnage entering our ports fell from 216,914 to 206,065. Owing to the added stimulus of the European war, the corresponding figures for 1796 were: American, 675,046; British, 19,669.[51] American shipowners were enjoying the extraordinary prosperity which filled our seaport towns with the fine old houses so familiar to New Englanders.

If our first national shipping policy achieved such admirable results in expanding our merchant marine and enriching our nation, is it vain to hope that we can learn something from it to-day?

[46] Johnson and others, *op. cit.*, ii, 6.

[47] Ames, *Works*, i, 45.

[48] Seybert, *Statistical Annals*, 294. Cited in Johnson and others, *op. cit.*, ii, 27.

[49] Mahan, *op. cit.*, i, 80.

[50] Johnson and others, *op. cit.*, ii, 28.

[51] *American State Papers, Commerce and Navigation*, i, 389.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

REPORT AND RECOMMENDATIONS OF A BOARD APPOINTED BY THE BUREAU OF NAVIGATION REGARDING THE INSTRUCTION AND TRAINING OF LINE OFFICERS[1]

OUTLINE OF BOARD REPORT

1. Scheme of report.
2. Scope of consideration.

PART I. INSTRUCTION (TRAINING) OF THE LINE OFFICER

3. Manifold requirements of naval profession.
4. Periodical instruction indispensable to efficiency.
5. Four phases of naval career.
6. Instruction (training) also in four phases.
7. Duration and time of training periods.
8. First period—the Naval Academy.
9. Second period—general line course.
10. Instruction and training for the duties of command.
11. Third period—junior War College course.
12. Fourth period—senior War College course.
13. Provision of necessary arrangements (time and numbers) for instruction and training.

PART II. SPECIALIZATION

14. Universal specialization required.
15. The "exchange" principle involved.
16. Specialists defined (delimited).
17. Specialists in design and production of material.
18. Specialists in manipulation of material.
19. Specialists for special duty only.
20. Other specialties pertaining to line requirements.
21. The officers of the staff corps (and Marine Corps).
22. Temporary exceptions from general line course.

[1] This report is published by permission of the Navy Department for the information of the service. The report of the Board has been approved, but the shortage of officers will not permit the recommendations to be carried into effect at present.

PART III. PRACTICAL CONSIDERATION

23. Initiation of recommendations.
24. General graph of employment—ensign to commander.
25. General training board.

Reference: (a) Bunav. let. No. 8039-198, 16 Oct., 1919.
(b) P. G. Dept. Nav. Acad. Let. No. 159, 27 Aug., 1919. (Enc. "A.")
(c) Bunav. 2d End. No. 8039-198, 10 Sept., 1919.
(d) Supt. War College 3d End. No. 733-2-2, 17 Sept., 1919.

1. The report of the Board is presented in two papers in order that on the one hand the "findings" of the Board may be readily comprehended (Summary), and on the other hand, that the considerations leading to the "findings" may be available for examination (Supplement). This paper constitutes the "Summary," whose paragraph numbering corresponds to that of the "Supplement."

2. In the scope of consideration entered into by the Board it has been found necessary to include the entire career of a naval officer, from midshipman to admiral; consideration is limited to the line officer, except where expressly stated otherwise. It is noteworthy that existing arrangements provide only for the special instruction of younger officers in matters relating to the design and production of material.

PART I. INSTRUCTION OF THE LINE OFFICER

3. The necessity for instruction (training) is deemed apparent from a review of the varied subjects of which a working knowledge is required by the efficient naval officer; subjects which embrace a multiplicity of arts, industries and sciences, whose advance is continuous and progressive.

4. Inasmuch as it is obviously impracticable and impossible to equip the officer for the whole period of his service during his initial instruction (Naval Academy) it becomes necessary to arrange and to provide for his further instruction and training at recurring periods.

5. The career of the commissioned naval officer from ensign to admiral is found to be comprised in four general phases, increasing progressively in responsibility and authority as his experience

and ability warrant, measure of which is clearly indicated by the established graded advance in rank.

TYPE CASES

Phase I. Inferior subordinate—division officer.
Phase II. Superior subordinate—head of department.
Phase III. Commanding officer—command of single ship.
Phase IV. Flag officer—command of group of ships.

6. Four periods of instruction (training) are found necessary, to be so distributed through the naval officer's career as to make it the general rule that an instruction and training period precedes the employment in an advanced phase of usefulness (as indicated in paragraph 5 above).

The *four* instruction and training periods are:

I. The Naval Academy.
II. The general line course.
III. The junior War College course.
IV. The senior War College course.

So that as

(a) The Naval Academy (initial instruction period) prepares for the earliest and lowest phase—inferior subordinate, so will—

(b) The general line course (second instruction period) prepare for the second phase—superior subordinate—and

(c) The junior War College course (third instruction period) prepare for the third phase—commanding officer—and

(d) The senior War College course (fourth instruction period) prepare for the fourth and highest phase—flag officer.

7. The length of time and the point in the service at which the instruction (training) periods should take place are found to be:

(a) Naval Academy—four years—preliminary and preparatory to commission, in readiness for first phase of usefulness—inferior subordinate.

(b) General line course—one year—between five and ten years commissioning (preferably after five years, general service) in readiness for second phase of usefulness—superior subordinate.

(c) Junior War College course—one year—between tenth and twentieth year of commissioned service (preferably while in the

grade of lieutenant commander) in readiness for third phase of usefulness—commanding officer.

(d) Senior War College course—one year—after twentieth year of commissioned service (preferably while in the grade of captain), in readiness for final phase of career—flag officer.

8. *Naval Academy.*—The purpose of the instruction and training of midshipmen at the Naval Academy is to graduate officers properly equipped to continue the study and begin the practice of their profession as "inferior subordinates."

9. *General Line Course.*—The function of the general line course is the unification and confirmation of previous instruction and experience of officers, and their progressive instruction in readiness for duties of the next higher order, *i. e.*, "superior subordinates." The curriculum proposed in Reference (b) is recommended for immediate adoption.

10. *Instruction and training for the duties of command* is essential to efficient carrying out of war operations in order that the whole body of commanding officers and of unit commanders and their staffs may have common conceptions of basic considerations and of practical methods which are requisite for the thorough co-operation and co-ordination which make "unity of action" a real and compelling factor in the attainment of victory. This instruction is best given in two periods: the first, before attaining command rank and the second before attaining flag rank.

12. *Senior War College Course.*—The purpose of this course is to unify and confirm all previous instruction and experience in the advanced elements of the profession, and to insure an adequate knowledge of the principles which govern the operation and administration of forces and fleets, in readiness for prospective employment as flag officer. This period of instruction is intended to provide for thorough training in the exercise of the command of fleets and fleet units.

13. It is considered to be to the highest interest of the Government not only to provide for the above recommended instruction (training) but to require it, in order that the naval service may be maintained at the highest possible degree of efficiency. The necessary arrangements should provide for the inclusion of an additional percentage to the personnel estimates.

PART II. SPECIALIZATION

14. The requirements of the naval profession are found to be such that provision must not only be made (a) for the progressive education of officers at recurring periods as recommended above, but also (b) for the specialization of all officers in at least one branch of the profession, in order to insure that full knowledge and use may be made of the constant progress in all of the arts, industries, and sciences, which can in any way contribute to the advancement of efficiency in naval warfare in any of its manifold aspects and requirements. Some of this specialization can be accomplished by instruction and some of it by suitable assignments to duty.

15. Since no officer can be equally proficient in all branches of the profession but should have as much knowledge of all as possible, it is necessary for officers to specialize, not only in order that full use may be made of development in individual fields but also that profitable "exchange" may be made among the body of officers composing the service, to the end that all may be acquainted to the fullest practicable extent with the advances and developments affecting the profession.

16. Every officer, while expert in certain fundamental elements of the profession, should be a specialist in at least one particular branch. Specialization divides into five general classes:

(a) Line officers who specialize in the design and production of material.

(b) Line officers who specialize in the manipulation (skill in use and operation) of material.

(c) Line officers for special duty only.

(d) Line officers who specialize in the requirements other than those which deal directly with material.

(e) The several staff corps and the Marine Corps.

17. *Specialists in Design and Production of Material.*—Certain line officers should be selected to be specially instructed and trained in readiness to fill the service needs for experts in the design and production of material. These specialists are those officers who are, as at present, specially instructed in the existing post-graduate technical courses. The majority of them, after performance of duty ashore and afloat in their several specialized lines, continue

in the line of the navy but some few elect "special duty only" as mentioned in paragraph 19 below.

18. *Specialists in Manipulation of Material.*—Certain line officers should be specially instructed to fill the service needs for expert and concentrated attention on the development of manipulation (skill in use and operations) of material. While all line officers must attain a degree of proficiency in these matters, only the attention of "specialists" can be expected to insure the highest possible improvements and developments.

19. *Specialists for Special Duty Only.*—Specialists of this class should not be selected until they have demonstrated their proficiency in the elementary stages of specialization and in the performance of duty in the specialty. The existing law permits this selection only after reaching the grade of lieutenant commander, which arrangement is considered satisfactory.

20. *Requirements Other Than Those Pertaining Directly to Material.*—Line officers who become experts, whether on account of education, instruction, employment or attention, in the theory and practice of leadership, management of personnel, the conduct of naval operations, organization and administration afloat and ashore, seamanship and navigation, etc.

21. *The Staff Corps and Marine Corps:*—

(a) The staff corps divides into two general classes.

(1) Combatant: naval constructors, supply officers, civil engineers.

(2) Non-combatant: medical and dental officers, and chaplains.

(b) So far as practicable, all officers of the combatant staff corps should, for the purpose of unified interests, be graduates of the Naval Academy.

(c) Officers of the non-combatant staff corps should receive, on entry into the service, some instruction in leadership, military character, etc., which can well be included in the curriculum of the medical school.

(d) Officers who are to be naval constructors and civil engineers should serve at least two years at sea and should preferably complete the general line course before beginning their technical education (see par. 22, following), in order that their future

specialized work may include practical comprehension of the relations between such work and the requirements afloat and ashore.

(e) Officers entering the Supply Corps and Marine Corps should, upon entry in these corps, receive a course of special instruction in suitable "schools of application" for their respective lines of work. Selected officers of the Supply Corps and of the Marine Corps should attend the junior and senior War College courses. Selected officers of the Marine Corps should attend the several Army schools which provide advanced education for operations on shore.

22. *Temporary Exceptions from General Line Course.*—While the satisfactory completion of the general line course requirement is considered indispensable for all line officers and for naval constructors and civil engineers, it is considered feasible to dispense with this requirement for officers who are selected to be specially educated by means of the existing post-graduate technical courses until such time as the existing shortage of officers becomes materially reduced.

PART III. PRACTICAL CONSIDERATIONS

23. *Initiation of Recommendations.*—While realizing that present service conditions may not permit the carrying into full effect of these recommendations immediately, the Board strongly urges the necessity for the adoption of a well-considered plan in order that matters may be shaped towards the general bringing of the definite plan into full force and effect, and considers it essential to the efficiency of the service that beginnings be made in regard to both instruction (training) and specialization.

24. *General Graph of Employment.*—Ensign to Commander—There appears herewith as Enclosure a graph indicating the general lines of employment in the career of an officer from ensign to commander. Endeavor has been made to generalize employment as much as practicable and to show, in addition to the three general instruction periods involved (Naval Academy, General Line Course, Junior War College Course), how specialization may be carried into effect, whether by instruction or employment, or both.

25. Coordination among and between the several agencies of instruction is required in order to ensure systematic progression and unity to the training scheme regarded as a whole. For this purpose a permanent Supervisory Board should be created.

SUPPLEMENT

1. *Supplement to Report of Board on Instruction and Training of Line Officers.*—This paper is the "Supplement" to the report of the Board. The paragraphs are numbered to correspond to the similar parts and paragraphs of the "Summary" of findings.

2. *Scope of Consideration Undertaken by Board.*—The scope of consideration by the Board is based on the phrase "any other recommendations pertinent thereto" in Reference (a) and on paragraph 4 of Reference (c), namely, that the proposed post-graduate general line course cannot properly be dealt with except as a component part of a whole scheme for the instruction and training of naval officers during their entire careers, from midshipman to admiral, both inclusive.

PART I. INSTRUCTION OF THE LINE OFFICER

3. *Reasons for Instruction of Commissioned Officers.*—

(a) The present advanced state of civilization includes great development in every branch of the arts, industry and science, so great that keeping abreast of developments in one branch of art, industry or science is practically a life-work. Development is proceeding at an ever-accelerating rate and the complication of activities is increasing continuously.

(b) The requirements of the naval profession have an even broader scope than indicated above. The naval officer must be prepared to combine all these technical elements into an organized and unified force in such a way as to have a maximum effect when exerted against an enemy. The navy as a whole must be operated as a unit, which requires high proficiency in such matters as organization, administration and management.

(c) The intimate dependence of efficiency of material upon efficiency of personnel imposes a further major requirement upon the officer. He should be an expert in the art of leading men, which

necessitates a high degree of knowledge of the underlying principles, if effective and united action is to be obtained in the face of the difficulties confronting naval forces in war.

(d) The opinion has been generally held, in the navy, that the only way to learn things is to do them. This opinion has had much truth and fact to justify it, but this idea has been undergoing a marked transformation in recent years. It is becoming realized more and more that although one cannot learn to do a thing by merely being told how it is done, such previous knowledge greatly facilitates learning how to do it when practical work is started. This knowledge affords its possessor a strong foundation, barren and useless in itself, but a firm basis upon which to build the structure of practical experience. Book learning, abstract knowledge, is like fertilizer; it does not, of itself, produce anything, but it stimulates growth and advance when the live seed, practical experience, is instilled into the soil.

4. *Periodic Instruction Indispensable to Efficiency.*—

(a) The naval profession is the most varied in the world; leadership, material, skill, judgment, operations—all are needed. The term "officer" is synonymous with "leader," which establishes the primary reason for existence of officers. In the earlier years of an officer's career, he is concerned with the exercise of his profession in employments of limited scope. As he advances in rank and experience, the performance of details becomes less important. In the higher grades "operations" becomes of paramount importance, while material and its manipulation, though essential, are viewed as the means to the end, and not, as earlier, the end itself.

(b) The naval officer required a working knowledge of many branches of human endeavor. At present, he is "educated" only in preparation for the lowest commissioned grade. In order to be of most benefit to the service and the country, in these days, he must not only be expected to interest himself of his own volition in the progress of matters which have a bearing on naval warfare, but the time must be set aside and the opportunity must be made for him to acquire up-to-date knowledge along professional lines. It is also the case that the education preparatory to initial commission does not, nor can it be expected to, prepare the naval offi-

cer thoroughly for other than the duties he will be called upon to perform as a junior officer. It is an introduction to the profession but is not, and cannot be, complete in itself, even were still more time allotted to instruction at this initial stage.

(c) Not only does progress in knowledge and in other matters affecting the naval profession take place, but even in the extreme case in which these matters might conceivably be considered stationary, the Government should, at recurring periods in a career of forty years' commissioned service, provide the time and opportunity for officers to be instructed along the lines with which their increasing rank and consequent responsibility calls them to be thoroughly familiar. The extreme case appears to be: Instruction for four years at the Naval Academy and then none for forty years of commissioned service. The Board considers recurring instruction periods (later defined and specified) as indispensable to efficiency.

(d) Successive periods of instruction and training occurring at intervals between periods of practical experience is the best means to develop judgment, which, in positions of great responsibility, is an attribute which is hardly of inferior importance to the ability to reason to a logical conclusion.

5. *General Outline of an Officer's Commissioned Service.*—

(a) The general progress of an officer's career is clearly indicated in nine stages which are represented by the several grades in the naval service: ensign, lieutenant (junior grade), lieutenant, lieutenant commander, commander, captain, rear admiral, vice admiral, admiral. These grades or their equivalents exist not only in every military and naval service in the world, but also in all so-called "civil" establishments whether government or private; the grades or stages are therefore generally representative of advance in experience and ability and in consequent responsibility and authority.

(b) In armies, the nine grades are considered to be comprised of three distinct phases, each consisting of three grades, or stages:

First three—company officers—officers of small units.

Middle three—field officers—command of larger units of one kind.

Last three—general officers—command of mixed units.

(c) The analogous case exists in the navy, but not quite in the same form, because of the necessities of the case in respect to the upkeep, operation and interior economy of ships, an element which has no counterpart in an army; there are, however, distinct phases which appear to be four in number:

I.	Ensign Lieutenant (j. g.) Lieutenant	Inferior subordinates; *e. g.*, division officers.
II.	Lieutenant Lieut. commander Commander	Superior subordinates; *e. g.*, heads of ship departments.
III.	Lieut. commander Commander Captain	Commanders of ships.
IV.	Rear admiral Vice admiral Admiral	Commanders of small and large groups of ships.

6. Accepting the principles expressed in the above paragraph, four periods of instruction (training) are found necessary, to be so distributed through the naval officer's career as to make it the general rule that an instruction period precedes the employment in an advanced phase of usefulness (as indicated in paragraph 4 above). The four instruction periods are:

I. The Naval Academy.
II. The general line course.
III. The junior War College course.
IV. The senior War College course.

So that as

(a) The Naval Academy (initial instruction period) prepares for the earliest and lowest grade—inferior subordinate—so will

(b) The general line course (second instruction period) prepare for the second phase—superior subordinate—and

(c) The junior War College course (third instruction period prepare for the third phase—commanding officer—and

(d) The senior War College course (fourth instruction period) prepare for the fourth and highest phase—flag officer.

7. The length of time and the point in the service at which the instruction periods should take place are found to be:

(a) Naval Academy—four years—preliminary and preparatory to commission, in readiness for first phase of usefulness, *i. e.*—inferior subordinate.

(b) General line course—one year—between five and ten years after commissioning (preferably after five years' general service), in readiness for second phase of usefulness, *i. e.*—superior subordinate.

(c) Junior War College course—one year—between tenth and twentieth years of commissioned service (preferably while in the grade of lieutenant commander), in readiness for third phase of usefulness, *i. e.*, commanding officer.

(d) Senior War College course—one year—after twentieth year of commissioned service (preferably while in the grade of captain), in readiness for final phase of career, *i. e.*, flag officer.

8. *The First Period—Naval Academy.*—The primary objects of the instruction and training of midshipmen at the Naval Academy are considered to be:

(a) To develop the mental capacity; principally the ability to reason to a logical conclusion.

(b) To develop military character, including discipline, the attributes of leadership, and the basic virtues.

(c) To supply knowledge of the technical groundwork of the profession.

The Board has no comment to make in regard to (c) above, but suggests that special attention be given to the development of the reasoning powers by direct means as well as by the indirect methods now in use; and also that steps be taken to improve the development of those aspects of military character relating to leadership. Emphasis is placed upon these two matters because the quality of leadership and the power of reasoning are indispensable attributes of an officer, regardless of rank or employment.

9. *The Second Period—General Line Course.*—The function of the general line course is the unification and confirmation of initial instruction and experience of officers, and their progressive and advanced instruction in preparation for duties of the next higher

order. The general line course effects the following purposes (letter consecutively with paragraph 8 above):

(d) To continue the development of the powers of analysis and reasoning.

(e) To confirm and to bring up-to-date the professional instruction of the Naval Academy from the view-point of at least five years' sea experience.

(f) To unify, and, as far as possible, to equalize the information acquired while performing assigned duties at sea.

(g) To introduce officers to some of the more advanced elements of their profession.

(h) To acquaint officers with the fundamental considerations which control economic, political and social relations.

The arrangements for this purpose proposed in Reference (b) are considered well adapted to the initiation of this essential part of the education of a naval officer. The general line course is recommended to be put into effect at the earliest practicable moment with as many officers in attendance as can be spared; and regardless of whether all eligible officers can, in the beginning, be detailed for this course or not.

10. *Instruction for the Duties of Command.*—

(a) The aim of the training system in higher command should be to meet service requirements not alone in commanders of fleets, squadrons, capital ships, and in departmental planning and administration, which need the present War College will ultimately meet fairly well; but also the need for commanders of smaller vessels, upon whose decisions the results of many important phases of tactics and strategy during war will depend, and the need for members of flag officers' staffs competent to do strategic planning, formulate doctrine, etc.

(b) When the present class at the War College graduates next June, 28 per cent of all admirals and 24 per cent of all captains on the navy list will hold War College diplomas; while only 5 per cent of all commanders and ½ per cent of all lieutenant commanders will hold them.

(c) Present policy with respect to rank of students will increase the percentage considerably in the higher grades—which appears essential—without materially affecting the percentage in the lower

grades—which appears unwise, considering the important duties which commanders and lieutenant commanders will be called upon to perform in war, as second in command of capital ships and as commanding officers of other important, even though small, fleet units.

(d) Our fleets cannot have sufficient cohesion in war operations unless the body of commanding officers as a whole has a common conception of war and is uniformly indoctrinated. These are difficult conditions to fulfil, unless the body of officers in the third and fourth phases as a whole receive adequate education and training in the higher branches of war.

(e) To meet the above need it is essential to establish a course of instruction for officers of the rank of lieutenant commanders (and perhaps junior commanders) who are approaching the third phase of their careers.

11. *The Third Period—Junior War College Course.*—This course fills the need for a periodic unification and confirmation of instruction and experience after about fifteen years' commissioned service, and provides for a continuation of instruction along advanced professional lines in preparation for prospective employment as commanding officer. Its functions (lettered consecutively with paragraphs 8 and 9 above) are considered to be:

(i) To continue the development of the powers of analysis and reasoning, particularly as to applications which arise in naval operations and warfare.

(j) To unify, confirm, and equalize service instruction and experience in technical matters.

(k) To confirm and continue instruction in the advanced elements of the profession, including training in the application of the doctrine and principles of naval warfare.

(l) To confirm and increase knowledge of economic, political and social sciences in theory and practice.

12. *The Fourth Period—Senior War College Course.*—This final phase in the scheme of training line officers is intended to provide a confirmation, summary and adequate familiarity with the higher advanced elements of the profession, chiefly those principles which govern in the administration, operation, and functions of forces and fleets, in readiness for prospective employment as

flag officers. Its principal parts (lettered consecutively with paragraphs 8, 9 and 10 above) are considered to be included in:

(m) To insure thorough understanding and facility in application of the principles and considerations which control the organization, administration, operations and functions of fleets and of fleet units.

(n) To insure comprehensive appreciation of the functions of the several offices and bureaus of the Navy Department and of bases and other shore establishments.

(o) Confirmation and continuation of instruction and training in the advanced parts of the profession, to insure thorough familiarity with the governing principles of international relations, strategy, tactics, logistics, etc.

13. The highest interests of the Government require that not only shall time and opportunity be provided for the above recommended instruction and training, but it should, for the purpose of maximum efficiency, be made obligatory, in order that the greatest possible benefit may be gained by the service as well as the individual. The necessary arrangements include the addition of a percentage to the personnel estimates, in order that while the necessary numbers required by other employments are not diminished, the numbers undergoing instruction for the necessary periods may be kept at full strength. It appears that the percentage in question is approximately nine per cent of commissioned line officers for all purposes, *i. e.*, 4 per cent taking general line course, 3 per cent the junior War College course, and 2 per cent in the senior War College course.

PART II. SPECIALIZATION

14. The necessity for instruction and training gains greater emphasis when endeavor is made to group the numerous and varied requirements of the naval profession into suitable and convenient "specialties," or lines of endeavor. The requirements of the naval profession are found to be such that provision must not only be made (a) for the progressive instruction of officers at recurring periods as recommended above, but also (b) for the specialization of all officers in at least one branch of the profession, in order to insure that full knowledge and use may be made of the

constant progress in all of the arts, industries, and sciences, which can in any way contribute to the advancement of efficiency of naval warfare in any of its manifold aspects and requirements. In some cases these requirements may be met by attendance at special schools, and in others by assignments to duty.

15. It is apparent that no officer can be really expert in all branches of the naval profession. It is, therefore, necessary that each officer specialize in at least one specific branch of the profession, in order that he may make a profitable exchange by giving his special knowledge and experience in return for that of others. While each officer gives the knowledge of one man, and that without taking away from himself, he receives in turn the ideas and information of many. The business principle, "that exchange is best which gives both parties the largest possible profit," has been found as successful in the exchange of knowledge as of commodities.

16. All naval officers should be experts in certain fundamental branches of the profession. Each officer should be a specialist in at least one specific branch of the profession.

Specialists should be of five general classes:

(a) Those officers of the line who specialize in a technical material branch with a view to supervising the design and production of material.

(b) Those officers of the line who specialize in a technical material branch with a view to becoming expert in the manipulation of the material of such branch.

(c) Those specialists who remain in the line of the navy but are limited to the performance of duty of a particular type.

(d) Those officers of the line who specialize in branches of the profession other than the technical material branches.

(e) The staff corps and the Marine Corps.

17. *Specialists in Design and Production.*—

(a) To a large degree, the navy designs and supervises the design and production of its material equipment. Each officer cannot specialize in each branch of the profession sufficiently to prepare him for this important duty. It is, therefore, necessary to train a certain number of officers as specialists in design and production. Some of these officers will later be assigned to special

duty only, but most of them will continue in the regular line duties, their abilities as specialists being employed only on short duty and in connection with manipulation of the material of their specialty at sea.

(b) No specialization of this nature should be permitted until after the completion of five years' sea duty and a satisfactory completion of the general line course. (See paragraph 22 following.)

(c) No officer should be permitted to specialize in any branch unless by his work in the general line course he has demonstrated that he is especially well qualified for such duty. In many cases the decision as to which branch an officer should be assigned for specialization should be determined by the staff of the General Line School. (See paragraph 22 following.)

(d) The general line course is a necessary preparatory step to specialization of any nature within the line of the navy. Specialists in design and production should, if practicable, take up the study of their specialty immediately succeeding their completion of the general line course. (See paragraph 22 following.) This special course should be as at present:

One year—post graduate "groundwork" school; then

One year—civil college or university.

18. *Specialists in Manipulation of Material.*—

(a) The manipulation of the mechanism of modern ships is so complicated that it should be supervised by officers who have had special instruction and training in its manipulation. This necessity introduces into the service specialists in the supervision over the manipulation of certain mechanical technical departments on board ship.

(b) These specialists, however, remain in the line of the navy and after performing the work connected with their specialty follow the route of the line officer unrestricted as to the type of duty to be performed.

(c) In view of the knowledge and experience gained by five years' service, and the review of technical subjects received in the general line course, it is considered that a six months' to one year's course should be adequate for qualifications as an expert in supervision of manipulation.

19. *Specialists for Special Duty Only.*—Specialists of this class should not be selected until they have demonstrated their proficiency in the elementary stages of specialization and in the performance of duty in the specialty. The existing law permits this selection only after reaching the grade of lieutenant commander, which arrangement is considered satisfactory.

20. *Other Specialties Pertaining to Line Requirements.*—

(a) It is believed that each officer should be a specialist in some branch of the naval profession. The study of leadership, management of personnel, the conduct of naval operations, organization and administration and of the purely seafaring knowledge such as seamanship and navigation, furnish ample ground for many specialists. The specialization in these branches is not inconsistent with the performance of normal duties.

(b) Specialists of this class are required, primarily, to study and investigate the ground covered by their specialties, in order to furnish to all officers in the service the most advanced views on these important subjects. Every element of the naval profession must be studied and the knowledge obtained by individual officers classified, collated and disseminated throughout the service for the benefit of the whole body of naval officers.

21. *The Staff Corps (and Marine Corps).*—

(a) The Staff Corps are divided into two classes:

Combatant: naval constructors, supply officers, civil engineers;

Non-combatant: Medical and dental officers, and chaplains.

(b) The instruction of officers of the staff corps is herein touched on only insofar as the proper performance of their duties requires training similar to that of the officer of the line.

(c) So far as practicable, all officers of the combatant staff corps should be graduates of the Naval Academy. The basic instruction of all combatant naval officers should be identical. The spirit of unity which should pervade all branches of the profession will be materially increased by this common education and the friendship and ties formed at the Naval Academy will materially increase the co-ordination of the branches within the service.

(d) The medical officers, dental officers and chaplains cannot be trained at the Naval Academy, but the Medical School in Wash-

ington should include in its curriculum the study of leadership, military character, etc. A short course should be arranged for dental surgeons and chaplains entering the service in order that they may have a broader conception of their duties on board ship and their relation to the personnel and the service.

(e) Officers who are to be naval constructors and civil engineers should serve at least two years at sea and should preferably (see paragraph 22 following) complete the general line course before commencing the study of their specialties. This course is essential in order that such officers shall realize that the various branches of the navy must work in harmony and that these officers may bring up to date their general knowledge of the profession before they specialize in any one branch.

(f) Graduates of the Naval Academy (or appointees from civil life) selected for the Marine Corps and Supply Corps should be immediately assigned to schools for instruction in their particular specialties, upon completion of which they should be ordered to the regular duty of the branch.

(g) The training of these officers should be provided for as follows:

Marine Corps: Marine Officers' School.
School of the Line (Marine). (All marine officers.)
School of the Line (Army). (Specially selected officers.)
Junior War College (Navy). (Specially selected officers.)
Staff School (Army). (Specially selected officers.)
Senior War College (Navy). (Specially selected officers.)
Staff College (Army). (Specially selected officers.)
Supply Corps: supply officer school (pay corps). (All supply officers.)
Junior War College (Navy). (Specially selected officers.)
Senior War College (Navy). (Specially selected officers.)

22. *Temporary Exceptions from General Line Course.*—

(a) It is deemed desirable, and even necessary, that *all line officers* shall take and satisfactorily complete the general line course before taking up their several specialties, for the reasons, given in the several paragraphs preceding. This view is also held in regard to naval constructors and civil engineers.

(b) However, since there is a shortage of officers which is expected to continue for some years, and as the post-graduate technical education which certain selected officers receive is useful in giving perspective and breadth of view, it is considered that the general line course requirement need not be made obligatory until the shortage of officers is materially reduced.

PART III. PRACTICAL CONSIDERATIONS

23. *Initiation of Recommendations.*—It is realized that the recommendations made above cannot well be initiated in their entirety at once, due to shortage of officers, the requirements of the service and for other similar reasons. The Board would strongly press, however, the necessity for the adoption of a well-considered plan such as this report is believed to contain in order that affairs may be regulated and arrangements made for eventually bringing the definite plan into full force and effect. The Board has indicated (in paragraph 22 above) where certain temporary modifications can be made but would urge, as indispensable to the efficiency of the service, that beginnings be made in all the several lines of instruction and specialization. The recommended training provisions can be got underway at once by utilizing the arrangements proposed for the general line course in Reference (b) and the facilities at the War College for the separation of the present War College course into the recommended junior and senior War College courses. Specialization of the kinds classified in paragraphs 18 and 20 above can be largely effected in the beginning by suitable details to duty afloat and ashore.

24. *General Graph of Employment—Ensign to Commander.*—

(a) An endeavor has been made to indicate, by means of the graph, which appears herewith as Enclosure "A", the progress of a line officer through his naval career from the date of his entrance to the Naval Academy until the completion of his junior War College course, assuming that the plan of instruction recommended by this Board is in effect.

(b) All line officers should be graduates of the Naval Academy or should have had extensive practical experience in the enlisted and warrant classes and training in a school of application.

(c) Upon the completion of the Naval Academy (or School of Application course) each officer should be ordered to a ship of the first rate for a period of from about two years. This period should be two years for those officers who desire to enter the Construction Corps or Civil Engineer Corps.

(d) From ships of the first rate officers are transferred to one of the following duties or types of ships:

(1) Aviation duty.
(2) Submarine duty.
(3) Destroyers.
(4) Light cruisers.
(5) Mine force vessels.
(6) Cruisers or gunboats.
(7) Auxiliaries.

(8) The nature of the duty to which officers are to be ordered should be dependent upon several factors:

I. Their desire for certain duty.
II. The recommendation of their commanding officer.
III. The available billets in the type desired.
IV. Their reports of fitness.

(e) Officers should, so far as practicable, remain in the type of ship (as listed in subparagraph (d) above), to which they are ordered until their first period of sea service (five years after graduation) has been completed.

(f) All officers of the same class or date of commission finishing their sea service together would be ordered to take the general line course.

(g) The curriculum of the general line course should be such as bring their knowledge of all technical branches of the profession up to date and to advance them in their knowledge of the profession, especially the elementary subjects of the operation branch.

(h) During the general line course student officers will be carefully watched by their instructors to determine in what branch of the profession (as indicated in paragraph (j) below), each officer should specialize.

(i) There should be no requirement to continue a previous duty in aviation or submarines unless the officer so desires and is recommended therefor.

(j) Upon completion of the general line course, officers will take up one of the following specialties:

(1) Operations specialties.
(2) Manipulation specialties.
(3) Design and production specialties.

(k) This specialization is made effective by:

(1) Schools.
(2) Duties assigned.

(l) The following schools should be provided for:

(1) Operations school
(2) Communications school
(3) Ship control school
(4) Aviation schools
(5) Submarine schools
(6) Engineering school
(7) Gunnery school
(8) Electrical school
(9) Torpedo school

} Course six months to one year.

(m) These schools need not each be independent. It is possible and preferable that, so far as practicable, these should be extension branches of the general line course and should be located in the same place though not necessarily in the same building.

(n) In addition to these schools there should be a post-graduate "groundwork" school for those officers who are to specialize in design and production. These officers upon completion of this post-graduate "groundwork" school course (one year) are ordered to civilian colleges for one year and then to sea duty.

(o) Officers assigned to any of the schools mentioned in paragraph (1) above complete the course and are then ordered to shore duty consistent with their specialty for the remainder of their time ashore.

(p) In view of the shortage of officers in the navy it will be impracticable to give all officers post-graduate work as described in paragraphs (m) and (n). Such officers should be assigned to definite specialties and ordered to shore duty where their duty and

training will assist them in their specialty. The diagram indicates duties of this nature to which officers may be assigned.

(q) Upon completion of this shore duty officers are ordered to sea duty in accordance with their specialties so far as practicable and the same considerations govern the succeeding shore and sea duty.

(r) By this time full use has been made of the specialization of these officers and they must be brought more closely together in preparation for command duty.

(s) This preparation is the function of the junior War College course. Upon completion of this course officers of the line who desire to specialize to the exclusion of command duty should be selected, as mentioned in paragraph 19 above.

25. (a) The scope of the Board's considerations has been such as to involve what may be called the framing of the "general specifications" of, first, the arrangements for the periodic and unified instruction and training of all line officers and, second, the provisions for the universal specialization necessary to the maximum development of the efficiency of officers and of the service. The Board has had at hand data which enables it to indicate the specific measures necessary to put into effect the training requirements for all line officers but is unable to go into the details of the provisions for specialization.

(b) General supervision of the training system should be provided in order to ensure due co-ordination among the several schools; otherwise there may be duplication of instruction, omission of some subjects essential to the harmony of a broad educational scheme, and a conflict of doctrines.

(c) Such supervision appears best obtainable by a permanent board on the training of officers, including among its membership the head of each school, representatives both of the Chief of Naval Operations and of the Bureau of Navigation, and such additional civilian or other members as may be determined upon. The secretariat of this board should be provided for and maintained by the Office of Operations.

UNITED STATES NAVAL ACADEMY
Post Graduate Department
Annapolis, Md.

Aug. 27, 1919.

To: Secretary of the Navy (Bureau of Navigation)
Subject: Proposed General Line Course, Post Graduate School.
References: (a) C. in C. letter file 1036 of 20 February, 1919.
(b) Operations 1st end. No date.
(c) Bunav. 2d end. N. 31 ATB-VAW of 18 April, 1919.
(d) Post Graduate Department letter 324 of 30 June, 1919.
(e) Bunav. letter No. 8039-198 of 31 July, 1919.

1. In reference (a), a recommendation to establish a course for education and training of officers for staff duty was submitted. References (b) and (c) approved the recommendations of reference (a) with a view of establishing the course at the Post Graduate School.

2. In reference (d) it was proposed, in lieu of the staff course, to establish at the Post Graduate School a "general line course" for the advanced instruction of commissioned line officers in professional and allied subjects, in order that the education of naval officers in general may be rounded out in more complete preparation for the many varied duties to which they may be assigned. The necessity of such procedure is supported by systems of post-graduate work employed by other nations, and by our army in its systems of schools for progressive advanced education of officers.

3. The general line course is designed to augment the elementary theoretical education received at the Naval Academy in the light of the practical experience at sea, with the object of broadening the officer's viewpoint and perspective beyond the limit of matters relating to interior organization and administration of the individual ships in which he has generally been engaged, in order that the efficiency of both the individual and the service at large may be increased. It will also serve advantageously to augment the Naval Academy course of those members of classes which were graduated, during the war, in three years.

4. The general line course will consist of pertinent review and instruction along the following principal lines:

(a) Up-to-date instruction in professional subjects; navigation; seamanship; ordnance and gunnery; electrical engineering; marine engineering; naval construction; etc.

(b) Advanced instruction in the principles of command, including organization, administration and maintenance, operations, including logistics and communications; international relations and intelligence; personnel matters, including military law and discipline; the planning, analysis and summarization of gunnery, engineering, and other exercises, etc.

(c) Lectures and instruction in general science and in the elements of logic, political economy, modern history, exposition, etc.

5. The following outline of the proposed course is submitted in accordance with paragraph 2 of reference (e). The course is outlined to cover

a period of one year divided into three terms with time employed as indicated in the following table (*Note:* subject to change as conditions and necessity warrant):

Subject	I term No. of hours		II term No. of hours		III term No. of hours	
	Class P.	W.	Class P.	W.	Class P.	W.
How to study	12	..	..	..	..	..
English exposition	16	..	..	..	..	..
Seamanship	12	15	6	..	..	..
Navigation	16	20	8	..	..	..
Ordnance	14	15	6	..	..	..
Gunnery	14	20	8	..	..	..
Marine engineering	20	35	10	35	..	..
Naval construction	8		4			
Electrical engineering	20	35	10	35	..	..
Radio	8		4			
Precision of measurements	12	35	..	..	..	..
Graphs	16					
Organization	..	..	9	..	..	..
Command	..	..	10	..	..	..
Administration	..	..	9	..	..	..
Scientific methods	..	..	..	..	14	..
Scientific land marks	..	..	..	..	14	..
Operations	..	..	28	35	42	105
Communications	..	..	..	..	42	70
Maintenance	..	..	16	35	..	..
Logistics	..	..	12			
Political economy	..	..	..	..	14	..
Political science	..	..	..	..	14	..
Policy	..	..	..	..	14	..
International law	..	..	..	..	14	..
Planning	..	..	14	35	..	..
Analysis and summarization	..	..	14			
Totals	168	175	168	175	168	175

Grand total: 1029 hours.

NOTE:—1. One hour each day except Saturday will be employed in physical training and exercise.

2. Each day is divided into five periods, *i. e.*, two one-hour periods for recitation, one hour of preparation, one hour of athletics (Saturday lecture), two and one-half hours in afternoon for practical work and exercises.

3. Examination will be conducted at the end of each term.

6. In general terms, the detailed requirements in the various subjects are as follows:

(1) *Seamanship.*—General review of elements, principles and applications, including types of ships, fittings and mechanical appliances; piloting; tactical data and methods of determination; handling and

steering ships singly and in formation, surface and submerged; towing; sweeping; boating; otter gear; nets; buoys; ground tackle; cargo stowage and handling; salvage; diving; rules governing organization and operation of merchant vessels; rules of the road; weather and laws of storms; current articles on handling ships in heavy weather; shoring; watertight integrity; mooring board problems.

(2) *Navigation.*—Theory and practice, including the duties of the navigator; description; use, and adjustment of the various navigational instruments and machines applicable to surface, underwater and air craft; charts, method of construction, general use, corrections and stowage; publications such as "notice to mariners", light and buoy lists, sailing directions; conventional notations and signs on charts; piloting and various methods of locating a ship's position near land; danger angles and danger bearings, serial and submarine fog signals; sailings; descriptions, care, and use of chronometers; different kinds of time used in navigation, the relation of same, and the conversion of time; the relation of sidereal time, hour angle, and right ascension; general solution of astronomical triangle; effects of errors in data and a consideration of the best time to observe for latitude, time, and azimuth; chronometer errors and methods of determining; rating; various methods of finding latitude, longitude and lines of position; the day's work; tides, currents, times of high and low water; identification of heavenly bodies; use of tables; solution of practical problems; theory of the deviation of the compass, description, errors, compensation, correction, care of both magnetic and gyro compasses; practical problems of chart room work, laying down courses and distances; plotting position, lines of position, contour lines, danger bearings, etc., and application of general rules of pilotage; use of sounding data, radio and sound signals in foggy weather; aids to surface, aerial and submarine navigation; military geography; observations with sextant and artificial horizon for longitude chronometer correction, latitude and azimuth; practical works.

(3) *Marine Engineering.*—History and progress of marine engineering with particular emphasis on late developments; theory of steam, air, and internal combustion engines; care, operation and upkeep of power plants of the several classes; specifications; trials standardization of indicators, gauges, instruments; metals, alloys, processes; boilers, design; general description; nomenclature and comparison of the several types; care and management of boilers; developments in oil burning; reduction gear; turbines; materials, physical properties and tests; thermo-dynamic applications; evaporating plants; Department bulletins and pamphlets; practical works and exercises.

(4) *Naval Construction.*—Types of hull and fittings; compartmentage; draining; underwater protection; specifications and characteristics for various classes including controlling influences; stability; aircraft; care and preservation.

(5) *Electrical Engineering.*—Elementary physics, electro-statics; storage batteries; instruments; elements and applications of D. C. and

A. C.; electrical machinery including generators, motors, rheostats, resistances, controllers, circuit breakers, detectors, insulations, wiring and appliances, transformers, alternators; electrical communication; switchboards; distribution boards; windings; tests, measurements; installations; electrical propulsion installations, care and operation; principles and application of wireless telegraphy; and telephony; listening devices; aeronautic instruments; practical exercises and laboratory work.

(6) *Ordnance and Gunnery.*—Gunnery instructions; developments in guns and mounts; battle ranges as affecting caliber; ammunition hoists; shells; explosives; mines; depth charges; torpedoes; bombs; optics; turret design and machinery; fire control methods and installations; director systems; ballistics; elements of dispersion and steps to eliminate; practical work and exercises with models at hand; ordnance pamphlets and instructions; inspection, care, operation and preservation of ordnance material; lessons derived from experiences of the war.

(7) *English.*—How to study; exposition, including principles of whole composition, paragraphs, sentence and word; outline development; transition; coherence; unity; limitation of subject; convergence; conclusions; punctuation; structure; political economy; political science; modern history; logic.

(8) *Command, Organization and Administration.*—Principles and application in the service generally and in the fleet in particular; pertinent parts of Navy and Fleet Regulations and Instructions; special instructions; organization sheets; general orders; administrative outlines; diagramatic representations; fleet standing orders; fleet routine orders; general orders; finance; etc.

(9) *Operations.*—Units and fleets; exercises; campaigns; movements; schedules for exercises in strategy and tactics; estimate of situation; formulation of orders; scouting; service of information and security; training; elements of gunnery and engineering efficiency; intelligence; war plans; inspections; performances; employment; practical problems, etc.

(10) *Personnel Matters.*—Health; welfare; military character; recreation; complements; training and transfer; military law and discipline as given in naval courts and boards, Naval Digest, courtmartial orders and special instructions.

(11) *Communications.*—Preparation and handling of correspondence and despatches; signal books; codes and ciphers; regulations, both navy and communication; applications and methods.

(12) *Logistics.*—Movements, supply of funds, fuel, ammunition, stores, equipment, provisions, clothing, transportation; ships data: train; bases, fixed and advanced; repairs; alterations; overhaul schedules; facilities; routine reports; inspections; tests; experiments; availability; maintenance and instructions governing same.

(13) *International Relations.*—Rules governing maritime warfare, usage, customs, ceremonies, duties of Naval Attache.

(14) *Planning; Analysis* and *Summarization* of gunnery, engineering and other exercises; orders of execution; rules, reports.

(15) *Policy.*—Means and methods of preparation for war, strength and character of types in ships, personnel, bases, fortifications; influence of geographical location; political relations with probability of war with other powers, and influence of alliances and coalitions; statistics on navies of other powers, both personnel and material; doctrine.

(16) *Precision of Measurements and Graphs.*—Theory of probability; determination of precision of observation by consideration of average deviation from the mean; relation between precision and the number of significant figures retained in computation; treatment of direct and indirect measurements; criteria for rejection of observations; propagation of error; discussion of relation between variables indicated by experimental data; discussion of types of equations with reference to suitability to represent by graphs; empirical data; empirical equations.

7. It is considered desirable that the first term in this course begin about 1 October, 1919, and that about 20 officers of the Naval Academy, classes of 1912, 1913 and 1914, be assigned. The number of students should increase rapidly from year to year until conditions and facilities are such that a whole Naval Academy class may return for the course.

8. It is planned, for the present, to carry on the instruction in the above-outlined course with the present Post Graduate Department faculty and facilities of the Naval Academy, thus involving no additional expense.

5 years after graduation

Aviation - 3rd 4 yrs.

Submarines.

Destroyers.

Light Cruisers.

6 years after graduation

Operation Specialties.

Manipulation of Ships.

Aviation Shore

Submarine Base

Ship Control Sch. Navy Yds or N.A.

8 years after graduation

Operations Sch. Nav. Dept - Dist.

Communication Sch. Nav. Dept - Dist.

Naval Academy Discipline

11 years after graduation

Big Ship
Watch - Division
Small Ship
Executive
Navigator
Staff Duties
Flag Lieut.

Big Ship
Watch - Division
Commen Off.
Small Ship
Executive
Navigator
Staff Duties
Flag Secretary

Big Ship.
Aviation Div.
Carriers - Tend.
Executive
Navigator
Watch - Division
Staff Duties
Aviation Staff

Submarines
Comd'g. Off.
Executive Off.
Sub. Tender
Executive
Navigator
Staff Duties
Sub. Staff

Big Ship.
Watch - Division
Small Ship
Executive
Navigator
Staff Duties
Personnel Off.

13 years after graduation

Shore Duty
Navy Department
Naval District
Navy Yards.

Shore Duty
Navy Dept. (Av.)
Inspection Duty
Aviation Stations.

Shore Duty
Navy Department
Inspection
Submarine
Bases.

Shore Duty
Naval Academy
Training Station
Navy Department
(Bu. Navigation)

16 years after graduation

Big Ship
Navigator
First Lieut.
Staff Duties
Operating Staff.

17 years after graduation

Aviation Only.

Naval Academy - 4 years.

Sea Service - Big Ship - 1st Yrs.

s. | Mine Force. | Cruisers - Gun Boats | Naval Auxiliaries. | Naval Constructor. | Civil Engineers.

General Line Course - 1yr.

Note: Officers selected for construction and C.E. corps take G.L.C. after years sea service.

Manipulation Spec. | Design - Production Spec.

Manipulation Personnel. | Manipulation Material.

Sea - Nav. Depts. N.A. | Engineering Sch. Navy Yds. or Bureau | Gunnery Sch. Navy Yds. or Bureau | Electrical Sch. Navy Yds. or Bureau | Torpedo Sch. Navy Yds. or Bureau

Naval Academy Ord Elec - S.E.

Eng. P.G. Sch. Civil Color Univ. | Ord. P.G. Sch. Civil Color Univ. | Constr. P.G. Sch. Civil Color Univ. | Civil Eng. P.G. Sch. Civil Color Univ. ..... 5 years after graduatio

Training Station | Morale Officers | Judge Advocate Gun Off.

Navy Department Bureau Navigation

Big Ship Watch - Division Small Ship Executive Navigator Staff Duties Personnel Off. Discipline Off.

Big Ship Electrical Off Watch - Division Small Ship Executive Engineer Off.

Big Ship Asst. Eng. Small Ship Engineer Off. Executive Off.

Big Ship Torpedo Off. Small Ship Executive Gunnery Off.

Big Ship Watch - Division Small Ship Executive Gunnery Off.

Shore Duty J.A.G. Office Bu. Navigation Recruiting Naval District

Shore Duty Bu. S.tes E. Inspection Navy Yards Naval Academy

Shore Duty Bu. Ordnance Inspection Tor Stations Naval Academy

Shore Duty Bu. Ordnance Inspection Navy Yards Gun. Factory Naval Academy

Small Ship Executive Off Comd'g. Off

Big Ship Engineer Off. Gunnery Off. First Lieut. Staff Duties Material Staff

Junior War College.

Line (Command) Duties

Engineering Only.

U. S. NAVAL INSTITUTE

SECRETARY'S NOTES

Membership

Life, regular and associate membership, 5460. New Members: 8. Resignations: 25. Deaths (7).

Lieut. Commander B. M. Snyder, U. S. Navy.
Captain O. E. O'Neill, U. S. M. C.
Lieut. R. L. Vaughan, U. S. Navy.
Lieut. F. W. Lively, U. S. Navy.
Ensign C. A. Wildman, U. S. Navy.
Rear Admiral O. W. Farenholt, U. S. Navy.
Captain G. R. Venable, U. S. Navy.

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The annual dues ($3.00) for the year 1920 are now payable.

Regular and associate members of the U. S. Naval Institute are subject to the payment of the annual dues until the date of the receipt of their resignation.

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The attention of authors of articles is called to the fact that the cost to them of reprints other than the usual number furnished, can be greatly reduced if the reprints are struck off while the article is in press. They are requested to notify the Secretary and Treasurer of the number of reprints desired when the article is submitted. Twenty copies of reprints are furnished authors free of charge.

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Original photographs of objects and events which may be of interest to our readers are also desired, and members who have opportunities to obtain such photographs are requested to secure them for the Institute.

Annual Election

Proxies for the annual election have recently been mailed to the membership. It is requested that all members fill these out and return to the Institute as soon as possible.

Notice

Whole Nos. 6, 7, 10, 13, 14, 15, 17, 144, 145, 146, 147, 149, 155, 167 and 179 of the PROCEEDINGS are exhausted; there are so many calls for single copies of these numbers that the Institute offers to pay for copies thereof returned in good condition at the rate of 75 cents per copy.

ANNAPOLIS, MD., July 15, 1920.

INFORMATION INDEX

	PAGE
ADVERTISEMENTS, INDEX TO	1
PUBLICATIONS, U. S. NAVAL INSTITUTE	(2)
SPECIAL NOTICE	1390
TOPICS FOR ESSAYS	1391
LIST OF PRIZE ESSAYS	1393

PROFESSIONAL NOTES

PREPARED BY

LIEUT. COMMANDER H. W. UNDERWOOD, U. S. Navy

GENERAL ARRANGEMENT

VESSELS BUILDING. — France 1295
NAVAL POLICY. — Germany 1299
MATÉRIEL. — Great Britain 1301
PERSONNEL. — Japan 1323
MERCHANT MARINE. — United States 1326
AERONAUTICS 1338
ENGINEERING 1346
NAVIGATION AND RADIO 1351
ORDNANCE 1360
MISCELLANEOUS 1363
CURRENT NAVAL AND PROFESSIONAL PAPERS 1368

FRANCE

FRENCH NAVY NOTES.—Since maritime expansion is par excellence the outward expression of the political and economic vitality of nations, naval interest attaches to the rapidity with which France is recuperating from the devastation and ruin inflicted without raison militaire by the hand of the infamous Hun. Practically the whole devastated area (3,200,000 hectares) has been cleared of projectiles, and half of it has already been tilled. Of the 5000 kilomètres of railroads that had been destroyed, 4000 have been reconstructed, as well as 3500 tunnels and bridges, whilst out of the 11,500 factories and mills that have been systematically destroyed or plundered, nearly 7000 have been reconstructed or placed anew in working order, which means a gigantic task that it will, of course, take years to fully complete, as all combatants know, though the Boche has failed in his object to permanently cripple that land of miracles Old Gaul.

The sporting fever has taken hold of the Navy which, as decided by the progressive Minister of Marines, is to take a prominent part in the London and Antwerp athletic competitions and to welcome any challenge from our British friends on the sporting field, for which preparations are being made at Cherbourg and Toulon. Mathurin is shortly to show what he can do in the Paris Regatta. Thus a promising new era is opening for French crews that can but improve in all-round quality.

A noteworthy feature of the protracted and eventful world-conflict was the long series of changes that took place in the command of the belligerent armies and fleets. Both the British Army and Fleet changed their heads twice, whereas three successive commanders have been in charge of both the French Army and Navy, Lapeyrère, Dufournet, and Gauchet in turn acting as Admiralissimos. As in the case of Marshal Joffre and of Gen. Nivelle, political intrigue rather than actual failure in their command caused the removal from active duties of the French naval chiefs.

The case of Adml. Dartige du Fournet is the most amazing, and, courts-martial being now very fashionable, it may become shortly the object of a Conseil de Guerre. This distinguished flag officer was, it will be remembered, in charge of the French battle fleet at Athens in December, 1916, when a party of French officers and sailors were treacherously attacked and murdered by orders of ex-King Constantino. He was relieved of his command by Minister Lacaze "for not having upheld with sufficient vigor the prestige of the Tricolor and avenged the foul murder of his seamen." The battleship *Mirabeau* had then fired a few well-aimed 12- and 9.4-inch shells on the Royal Palace, just the number sufficient to bring the traitorous Tino to his senses and to obtain the surrender of Greek artillery. The French Commander-in-Chief had the means of reducing Athens to ashes. Under similar circumstances a Boche admiral would not have hesitated a minute. But the chivalrous admiral, who had previously shown his decision in several instances and notably as second of Capt. Bory at the attack of Bangcock (1893), has nothing Boche in him, and for the sake of Old Greece and of civilization he refrained from bombarding and destroying wholesale some of the finest art treasures of antiquity, not wanting besides to visit on many thousand innocent people the crime of a few rascals. It is certain that France's position in the Levant is all the better to-day for the generous course adopted by Mons. Dartige du Fournet. Baby-killing, moreover, is not in the French line. Still, since the scandalous impunity enjoyed by Boche war criminals, there are not a few military and naval experts on this side who think that "next time" it would be an absurdity and weakness for France to try and "humanize war" and to refrain from "hitting first, hard and long" on these magnificent targets which large Boche cities and industrial centers offer to aerial bombardiers and to super-cannon. Safety lies along that course.

There have been of late a large increase in the number of 700-850-ton avisos, commissioned for auxiliary duties with the fleet and on colonial stations, where these gunboats form the French counterpart to the fine ultra-rapid British cruisers of the "C" and "D" classes, and there is less and less tendency on the part of our naval men to boast of these war acquisitions, that are both in their hulls and motors patched up, badly-designed affairs, little more than make-believe from a military standpoint and laughed at by every experienced constructor. The lines are faulty, the nautical qualities deficient, and the silhouette ridiculous, resembling neither a bonâ-fide cargo boat nor a warship. "C'est l'œuvre d'apprentis-ingénieurs," declared an old naval man, and a similar observation is being freely applied to the 1400-ton cargo boats of the *Verrier* type, also designed by good-intentioned gentlemen of La Section Technique, and which, despite satisfactory paper qualities, have turned out to be somewhat lacking in structural robustness and nautical qualities, so much so that there is no undue haste to sail in them. This shows that personal acquaintance with sea conditions is no less necessary than scientific attainments for the efficient designing of sea craft. The truth is that our "ingénieurs du Génie Maritime," who are over 150 in number, possess superior capabilities so far as theoretical paper work is concerned, their mathematical training absorbing much more time and attention than is the case in any other navy, but, on the other hand, their practical and business training leaves much to be desired, and it has long been felt that the whole branch is in need of a thorough reorganization on new lines. There is something to be learnt in this respect from the British and American navies. Already a "mission" of ingénieurs d'artillerie navale" under General Charbonnier has been sent to visit American gun factories, and it is probable that Paris constructors, who have given up warship designing for the last five years, will likewise seek information in those Allied yards reputed to lead in the matter of rapid and up-to-date construction.

The examination of recuperated Boche and Austrian scouts, though it has been no revelation to Paris experts, had led to minor changes in the projected éclaireurs, but the opinion is gaining ground that the whole cruiser program falls short of France's requirements, and no wonder. England and America can afford to excel both in the matter of number and quality, whereas our Republic, financially unable to compete with her great allies, has to be satisfied with superior quality, this being a sine-quâ-non condition of the efficient peace rôle and war utilization of warships. Now, superiority means a two-fold advance over all contemporary designs for both speed and calibre, and notably the faculty of escaping from the deadly reach of all rivals with heavier armament. It is because it did not meet those requirements that the fine German cruiser force, that would have done wonders against France, proved of so little avail against the superiorly designed British ocean greyhounds. This means that the 5.5-inch calibre, however improved, is no longer adequate, the latest American and English light cruisers mounting 7.5- and 8-inch weapons; and as to the speed of 30 knots, it is ridiculously out of date in these times of 33- and 35-knot battle-cruisers and scouts. Such are the facts. Sea power is getting more and more expensive, and the longer the delay the heavier the outlay will become. Eloquence and literature are no remedy, unfortunately, for our peaceful Republic resembles in one respect the Seigneur Harpagon, the hero of Molière who wanted "beaucoup de bonne cuisine avec peu d'argent." Over 500,000,000 francs will be squandered this year in the upkeep of a huge army of useless parasites and anarchistic prolétaires des arsenaux, whilst the utmost parsimony presides over the measuring of the credits devoted to the forging of the weapons of the national defence. Still, it is felt action will have to be resorted to, and the curtailing of useless expenditure, that is proceeding steadily, will in a few months hence permit an effort to be made with a view to retrieving the situation in the Mediterranean, where our Italian friends are claiming supremacy. The super-Dreadnought *Caracciolo*, which was launched last month, is not likely to be completed without France adopting a similar step concerning the *Flandre*, *Gascogne*, and *Normandie*, that have not been officially discarded and could be ready, with minor ameliorations in their design, by the end of next year. The bulk of naval opinion is now in favor of the completion of these powerful super-dreadnoughts, that would procure France security and prestige in the Middle Sea. There are signs of a reaction in favor of the much-abused mastodon. Superior power is not attainable without superior size. In the present state of the naval science, and since the submarine and aerial menaces have been squarely faced and guarded against, David cannot be said to stand much chance against Goliath.—*The Naval and Military Record*, June 9, 1920.

FUTURE OF NAVAL AVIATION.—Should Minister Landry succeed in discarding the battleship programme and in doing away for a time with the mastodons "qui n'ont rien fait pendant la guerre," he will go counter to the desire of the bulk of naval men and deal a damaging blow to the naval prestige of the Republic, since there is no questioning the capital value of the mastodon to show the flag in peace time and to assert the command of the high sea. On the other hand, nobody can deny his work-power and his patriotic intentions to make up for the temporary weakening of the armored squadrons by an energetic expansion of the fleet along the lines of la jeune école. Even if financial considerations and his limited tenure of office should combine to prevent his securing for France that speed supremacy which Admiral Aube's powerful imagination pictured as the primary factor of success on the water and as the most vital asset for Powers financially and numerically outmatched (a somewhat contradictory ensemble of requirements), the capital service he will have rendered to naval aviation will ever be a feather in his cap and cause his Ministry to

be favorably remembered. For he is the first Minister of Marine to have entered Rue Royale with the set determination of making the Gallic Navy supreme in the aerial branch, and with the clear knowledge that an ambitious programme of that sort demands to be realized something more than that unexcelled verbal activity which is the glory of our Republic, viz., persevering will and a firm hand that will brush aside mercilessly those good-intentioned, but obsolete, officials whose narrow minds, cramped up with the beliefs of the dead past and with conventional doctrines, leave no room for new ideas and for the study of the rapidly-changing aspects of the war game, who too long have found delight in thwarting the efforts of the far-seeing pioneers of naval aviation and in sacrificing the interests of their country to their senile prejudice.

The official contention is that aviation is the line of naval activity in which the greatest results can be obtained in the shortest time with the least expenditure, although the creation of a really efficient aerial wing is not so easy a job as might appear at first sight to judge from the fact that "l'aviation navale Française," that was the first in the field, is yet in its infancy so far as the matériel is concerned and is under the obligation of defending its precarious existence against the ill-will and jealousy of the older branches of the services. Moreover, naval aviation is expected, with time, to command effectively narrow passages and those inland seas, such as the Mediterranean, which are studded with islands strategically suited for the rôle of offensive aerial bases. Secondly, France is deemed to be in a privileged geographical situation so far as the effective utilization of maritime aviation is concerned, only being excelled by Great Britain in that respect.

At the same time, it is clearly seen, on the morrow of the fiasco of the cross-Mediterranean flight, that a methodical and persevering effort has to be made before aviation can be considered as a thoroughly seaworthy weapon to be relied upon in all weathers. And the first condition necessary to success in this direction is to ascertain the causes of past failure and speedily remove them. If financial and industrial means of action, together with inventive genius and genuine enthusiasm on the part of young officers, had been the only things that were needed to create a powerful air wing, the 1911 Daveluy aerial programme, comprising scouts as well as fire control and bombardment hydravions, would have been ready at the time of the Boche aggression, and the whole course of hostilities might have been changed; the Goeben would not have bombarded French ports with impunity, Cattaro and Pola would have been promptly made untenable to the Austrian Fleet, and the underwater mosquito would have lost much of its sting. Unfortunately, as noted by Adml. Daveluy, "vouloir" was sadly wanting; that is, a well-defined and stable policy and unflinching will in the realization of the same, desiderata hardly compatible with the continual change of improvised Ministers (seven since 1914) and the consequent rise to the top of the naval hierarchy of gentlemen generally more eminent by their talent for intrigue and verbal attainments than by their solid practical qualities. A comparison between the parallel developments of French and English aviation speaks for itself. So far back as 1910 Admiral de Lapeyrére publicly confessed his enthusiastic belief in the naval possibilities of aviation, and the best brains of the service then tackled in earnest the study of the new problems, only to find out their powerlessness to achieve anything against the systematic inertia of the Admiralty bureau intent on demonstrating that seaplanes were "de fragiles jouets," and aviators mere lunatics, and delighted at the opportunity the outbreak of war offered them to suppress, once for all, that despised "service aéronautique." The seaplane mother ship *Foudre* was turned to other duties, and the few machines (14) and pilots then available lent to the army and to the English Navy. After the broadminded and enterprising British maritime authorities had demonstrated at Cuxhaven

and in the Dardanelles the scouting and offensive worth of flying machines, official attention was reluctantly turned to avions that had increased to 1100 by 1918, whilst over 60 aerial stations had been created along French coasts, but even then the French aviation maritime remained a purely defensive force in contrast with the larger and offensively-organized British seaplane fleet. On the morrow the war, Admiral Ronarch, the hero of Dixmude, who had got personally acquainted at Dunkirk with the possibilities of aerial bombardment, availed himself, with his ephemeral and mostly nominal powers as chef d'etat-major general, to place in hand an imposing aviation programme, comprising powerful machines of 500-horsepower and more designed for 12 hours' continuous flying and intended to eventually assure to France the aerial command of the Middle Sea. Instability, ill-will, and anarchy at the head, and consequent neglect on the part of red-tape officials have caused most of the avions he ordered to rot unused in harbor. Of the 60 seaplanes that were, in August last, to fly over the Mediterranean and back, hardly half a dozen have come up to expectations.

At the same time, a brighter outlook is opening for aviation under the present Ministry. While our naval aviators do not as yet receive the counterpart of the advantages and encouragements enjoyed by their British colleagues, they are no longer being systematically put down and overlooked at promotion time. Com. Lefranc, one of the best-known service airmen, has just been raised to the superior rank, and a similar reward awaits the several officers who have of late distinguished themselves by their flying exploits. The flying sport is being encouraged in the ports militaires, and also in the battle force by Admiral Charlier, who has just taken the effective command of the Mediterranean aerial force, and has announced his intention to test to the utmost the actual scouting and offensive capabilities of seaplanes, as well as of the few A. T. dirigibles placed at his disposal. Henceforth there are to be no fleet maneuvers without avions being at work overhead in their various rôles. Similar experiments on a perhaps larger scale are to take place in the Italian Navy, which is just now under the guidance of jeune école converts; tendencies which apparently justify the forecast of experienced naval men that a few years hence the mastodons will be definitely ousted from the Mediterranean and seek refuge in the vast and well-sheltered Atlantic roadstead of Brest. There are signs that time is working for aviation in gradually relegating to oblivion those retrograde bureaucratic officers responsible for the slow and unsatisfactory progress of the aerial branch, and in replacing them by new men imbued with new principles and alive to the capital fact that the art of war is not for a moment at a standstill, but perpetually modified by some novel innovation, and that true efficiency is made up of constant research and watchfulness and of quick decision.

The problem of the light, handy, and transportable fleet seaplane has been solved by our naval aviators. Swift Spads and Nieuports make the best "hydravions de chasse" in existence. With the co-operation of private industry, aerial dreadnoughts of over 40 meters span and 2500-horsepower will be added to the Landry programme for six scouts, 12 super-destroyers, and 12 super-submersibles of cruiser speed.—*The Naval and Military Record,* June 23, 1920.

GERMANY

A FUTURE ON THE WATER.—Recent events in Germany have given no encouragement to the pious hopes of a naval renascence expressed by Tirpitz, Scheer, and other distinguished members of the former "Kaiserliche Marine." Admiral Hollweg, writing in one of the Hamburg journals, paints a gloomy picture of the future of German sea power. Herr Noske, the late Minister of Defence, made intelligent and purposeful endeavor to save from the ruins of the old navy the best of its experience and traditions, in

order to apply them to the building up of a small but efficient fleet, but according to Admiral Hollweg the effort has been a failure. For the past year a number of the best officers have been giving loyal and devoted service to this end, but without the least success. "Discipline and obedience were indispensable elements in this work of reconstruction, but both have been wanting. Thanks to the demoralizing influence of the seamen's federations, the personnel failed at the first test. The entirely correct attitude of the Commander-in-Chief at Wilhelmshaven availed nothing; the men's confidence in their officers was undermined by agitation, and the Kapp 'Putsch' brought matters to a head." It is a pity that the admiral is not more explicit on this point. What he says suggests that the sailors feared that they might be made the tools of a Monarchist coup, and promptly took measures to avert any such danger. Be this as it may, Admiral Hollweg regards as quite hopeless any further attempt to create a new navy out of the existing material, and he asserts that an overwhelming majority of the officers are resolved to have nothing more to do with a "pseudo-navy run on trade union lines and administered by Soviets." Here and there, he admits, an officer may be found willing, for opportunist reasons, to subordinate himself to the Soviets; but "such officers will not be of the best type; they will simply be mercenaries and parasites." The Soviets insist that all executive positions shall be filled by warrant and petty officers, a scheme which the admiral denounces as Utopian. "Should it materialize, there will be constant friction, for every seaman will want to be an officer."

Since both Kiel and Wilhelmshaven are hot-beds of revolution, Admiral Hollweg proposes that they be abandoned as naval bases and that the navy, as it now exists, be entirely disbanded. "It is a grave and difficult decision, but there is no alternative. It means more than the temporary renunciation even of a small navy; it seals Germany's fate as a nation cut off from any share in sea power, either military or economic. England's victory is absolute. It seems the special fate of navies to disappear amidst revolutionary upheavals. England alone, with her instinct for the sea, has known how to avoid such a disaster in these troubled times."

There is, he considers, only one way of preserving for Germany a modest share of sea power: an entirely new fleet of small dimensions must be built at a new base, such as Pillau, Swinemünde, or Stralsund, where its personnel would be far removed from the revolutionary atmosphere prevailing at Kiel and Wilhelmshaven. In the new navy politics would be entirely barred and the Soviet influence excluded; discipline, obedience, and loyalty to the Constitution would be the ruling principles. To ensure the success of the plan it would be necessary to appoint some distinguished officer to the head of affairs, and Admiral Scheer is suggested as the best candidate. It remains to be seen whether Admiral Hollweg's scheme will find any substantial support. From all accounts the nation at large has lost interest in the sea and everything pertaining thereto, and is determined to apply what energy and resources it still commands to the re-establishment of national industry and trade. Consequently, unless some wholly unforeseen development occurs, there is little prospect of a new German fleet coming into existence within the next few years.

In common with Tirpitz and Scheer, Admiral Hollweg appears to throw the entire blame for the old navy's collapse on to the shoulders of lower-deck "politicians" and "sea lawyers." But in justice to the German seamen it must be remembered that they were only following the example set by many of their officers, from Grand Admiral von Tirpitz downward. Politics seemed, in fact, to be the sole hobby of 90 per cent of these officers. They took a prominent part in the Press agitation which contributed so much to the embitterment of Anglo-German relations; they ardently supported those political factions which were working for war, and the Admiralty Press Bureau continued for years to issue a steady stream of violently partisan literature. Nor can naval officers disclaim responsibility for

the class hatred from the effects of which they are now suffering. It was often said in pre-war days that the wardroom of a German warship was more exclusive than the Court of Austria. The engineer officers were treated as social inferiors with whom it was derogatory to associate except in purely service affairs. Few executive officers displayed the least sympathy with or understanding of the lower deck, and we know from subsequent revelations that this ultra-aristocratic exclusiveness continued right through the war. In the manifesto published by the revolutionaries at Kiel the officers were charged with having lived like fighting-cocks while their men were on half-rations, and Captain Persius is not the only witness who corroborates that charge.

Labor troubles and shortage of material, but especially the former, are still imposing a heavy handicap on the German shipbuilding industry. There have been three lock-outs at the Schichau yards in Danzig and Elbing during the last eighteen months, and, although work is now in progress there, the firm still complains of its inability to fulfil contracts owing to the low rate of production. After months of bickering with its many thousand employees, the big Blohm and Voss concern at Hamburg has closed down, and is threatening to make the lock-out permanent unless the workmen promptly come to terms. Meanwhile the papers bemoan the ruin that threatens German industry if the Allies persist with their demand for the surrender of tonnage. They declare that the 300,000 gross tons of shipping still remaining in Germany will not suffice even for the carriage of the iron ore which is urgently needed; that East Prussia, now cut off from the Fatherland by the "Danzig corridor," requires large quantities of war material and foodstuffs which can only be carried by sea, and not a single ship is available for the purpose. "Notwithstanding these facts," says 'Schiffbau,' "the Entente demands the handing over, under the peace terms, of half the total number of vessels between 1,000 and 1600 tons gross, a demand that is incomprehensible considering that the Entente at the same time insists on the reconstruction of the devastated territory in Belgium and France, besides the fulfilment of all other conditions of reparation. Instead of making it possible for Germany to furnish her industry with raw materials and her population with food and work by allowing her to keep these ships, the Entente is adopting the contrary course, and thus putting it out of her power to fulfil her various obligations." One of the largest ironworks in north Germany has issued the following statement: "The confiscation of our remaining ships will probably compel us to close down, since they are now the only means we have of importing raw material. Foreign tonnage is much too expensive, and is not to be had. Our works can continue open only so long as they are fed from the sea. The effects of confiscation on the north German iron industry—the main source of supply—will be simply incalculable." In a word, Germany begins to experience the first effects of the world-wide shipping famine caused by her mad orgy of submarine ruthlessness. She is also beginning to realize that the loser pays, and evidently finds the process a painful one.—*The Naval and Military Record,* May 26, 1920.

GREAT BRITAIN

British Navy Estimates

STATEMENT OF THE FIRST LORD OF THE ADMIRALTY.—An analysis of the gross expenditure of £96,490,181 estimated to be incurred in 1920-21, shows that it can be approximately divided into:

(a) Non-recurrent war liabilities or terminal charges.....£19,077,000
(b) Recurrent expenditure due to war conditions, *e. g.*, increases in prices and in rates of wages, pensions, etc., and separation allowance 40,023,200
(c) Normal expenditure on basis of pre-war rates and prices.. 37,489,981

On this basis, the following comparison of the gross estimate for 1914-15 with the gross estimate for 1920-21 can be made:

1914-1915		1920-1921		
Gross estimate	£53,573,261	Gross estimate		£96,590,181
Deduct amount included for new construction..	18,373,000	Deduct war liabilities including new construction.	£19,077,000	
		Deduct recurrent expenditure due to war conditions	40,023,200	
				59,100,200
	£35,200,261			£37,489,981

The increase of approximately £2,290,000 over the provision required in 1914-15 is due mainly to the following causes:

The grant of clothing allowances to men of the fleet.

Provision of larger hospital ships.

The extension of scientific research and of technical training.

Reduction in the hours worked by the industrial staff.

Increase in non-effective charges.

The number that we propose shall be voted in Vote A for the maximum number of the personnel of the fleet to be borne on any day during the financial year, is 136,000 as compared with 151,000 in 1914-15. The numbers at the date of the armistice were 407,316, and by November, 1919, had been reduced to 157,000. The actual number required for the reduced fleet which it is proposed to maintain during the year is 127,500; but the provision under Vote 1 for the pay of the fleet has been based on the assumption that 131,000 officers and men will still be borne at the end of the year, as it cannot be expected that all those who are surplus to our reduced requirements can be disposed of during 1920-21.

There is great difficulty in suddenly effecting large decreases or increases in naval personnel, and the reduction of over 25,000 officers and men in the 17 months from last November to April 1921 will, if accomplished as we hope, be a remarkable feat. It must be remembered that the crew of a ship is made up of numerous small groups of individuals of many trades—gunnery ratings, torpedo ratings, engine-room ratings, signal ratings, electricians, armorers, mechanics of many kinds, and so on, each group possessing entirely distinct qualifications and having an entirely distinct duty, but each absolutely essential to the fighting efficiency of the ship. In every adjustment of naval personnel, provision has to be made for each of these numerous branches of skilled men to be kept up to strength in every ship all over the world; any attempt to wash out naval personnel with a broad brush at once immobilizes far more units of the fleet than was ever intended.

The time is opportune for an explanation of some of the principal decisions which the Board of Admiralty have taken, and of the motives by which they have been guided, while framing these estimates which may perhaps be described (in spite of the considerable provisions for war commitments which they embody) as the first of the new series of peace estimates. I therefore append some notes on naval policy, and a note on dockyard policy. It should be understood that these statements do not purport to be exhaustive even of the decisions already taken, still less of the matters which are engaging the attention of the Board.

NOTES ON NAVAL POLICY.—(*a*) *General Remarks:* 1. During the past year it has not been possible to frame a definite statement on naval policy owing to the changing situation, the necessity for keeping the fleet pre-

pared for eventualities during the armistice period, and the active operations imposed on the navy in the Baltic.

2. It is now possible to estimate more clearly and closely what are the requirements of the future, and to make what it is hoped will be regarded as a fairly full statement of our naval commitments and proposals.

3. Since sea power is essential for the security and prosperity of the British Empire, it is the object of the Board of Admiralty to proceed on lines which they believe will provide us with our vital requirements and at the same time secure the exercise of rigid economy. The expenditure necessary for such a policy is merely an insurance of our existance, and a guarantee of our increased prosperity.

4. In view of the vast efforts made during the years of war, it is possible for us to-day to suspend production for the time being and concentrate largely on assimilating the lessons of the war, the fleet being reduced to minimum requirements as regards both personnel and matériel.

The organization of the fleet as shown in Appendix I represents these minimum requirements.

5. In the first place we have certain definite duties to perform in support of allied policy, and to assist in stabilizing the disturbed conditions which at present prevail in the world.

We have also to provide the units necessary for maintaining adequate sea-going training for our personnel.

We have to station small cruiser squadrons on foreign stations, North and South Atlantic, Pacific, Indian, China, and Australian waters to assist our trade and support the needs of the Empire.

Finally, we have to meet the requirements of technical training to ensure progress in modern devices and methods of warfare.

(*b*) *Strength of the Sea-Going Fleet.*—6. We have based in home waters our main fleet, the Atlantic Fleet, consisting of 1 fleet flagship, 2 battle squadrons together comprising 9 ships, a battle cruiser squadron of 4 ships, one of which is conveying His Royal Highness the Prince of Wales on his tour of the Dominions, 2 light cruiser squadrons, 4 destroyer flotillas and attendant vessels. This is the least number of units to ensure progressive tactical and sea training. A lesser number would destroy the possibility of exercises at sea under realistic conditions; the tactical units would be reduced to such an extent that the problems of gunnery concentration, fleet torpedo tactics, destroyer attacks, anti-submarine tactics could not be studied and practiced; the sea training of officers and men would suffer, and progress would cease. To have one fleet in which the lessons of the war can continually be practiced and new tactical methods devised has been one of our principal objects in maintaining that the Atlantic Fleet should be of the strength laid down.

7. In the Mediterranean we have stationed a squadron of 6 battleships, 1 light cruiser squadron, 1 destroyer flotilla and attendant vessels. This moderately strong force is, in our opinion, necessary to meet political conditions in the near East. That this force is not excessive is shown by the fact that it has recently been necessary to detach a squadron from the main, or Atlantic, fleet to the Levant, the Mediterranean Fleet being fully employed on other important duties, and unable to meet all the demands made upon it.

8. As regards the squadrons on the China, African, North and South American and East Indies stations, the need for them, which has always been recognized in the past, has never been more urgent than it is to-day, in view of the necessity for re-establishing the internal trade of the Empire, and promoting that with foreign countries. The navy constitutes that police of the seas, and all experience teaches that an efficient navy is the surest guarantee for peace.

(*c*) *Remarks on the Capital Ship.*—9. There has been some criticism of the maintenance in commission of the present types of vessels, especially

in regard to the capital ship. A contrary policy has been openly advocated, this policy being based, it is presumed, on the idea that the battleship is dead and that submersible and air vessels are the types of the future. The naval staff has examined this question with extreme care, and as a result we profoundly dissent from these views.

10. In our opinion the capital ship remains the unit on which sea power is built up.

So far from the late war having shown that the capital ship is doomed, it has on the contrary proved the necessity for that type. On the German side the whole of the submarine campaign against merchant vessels was built up on the power of the high sea fleet. On the British side the enemy submarines in no way interfered with the movements of capital ships in carrying out operations; destroyer screens, new methods of attack and altered tactical movements defeated the submarine.

11. Not at present could the Board of Admiralty subscribe to the statement that aircraft have doomed the capital ship. Aircraft are certainly of the highest importance in naval tactics, as regards reconnaissance, torpedo attacks and artillery observation, but their rôle in present circumstances is that of an auxiliary and not of a substitute for the capital ship. The past history of this question must be taken into account; many times has the doom of the battleship been pronounced. The introduction of torpedo craft was believed in certain quarters over 20 years ago to have settled its fate. The Board of Admiralty at the time refused to be carried away by the attractiveness of the idea of building small, cheap torpedo craft instead of battleships, and they proved to be right. History has shown that the introduction of a type to destroy the capital ship has been quickly followed by the evolution of counter-measures which sustain its power.

12. We therefore believe that the battleship must remain the principal unit, and that fleet tactics and tactical training must be carried out with the battle squadron as the main unit. Nevertheless, it must be emphasized that although the battleship remains, its type may require to be altered. Advances in electricity, in the internal combustion engine and in science generally will inevitably necessitate an eventual change of type, and it is one of the principal functions of the Naval Staff to keep continuous watch on scientific development, with the object of ensuring that the type of capital ship designed meets the requirements of the future. It is even possible that the present battleship will change to one of a semi-submersible type, or even of a flying type, but such types are visions of the far future, not practical propositions of the moment. By gradual evolution and development the types forecasted may arrive, but the immediate abandonment of the capital ship in favor of a visionary scheme of aircraft and submarines would leave the British nation destitute of sea power and without the means of progressive training.

(*d*) *Harbor Establishments.*—13. There remains to be considered that part of our fleet organization which deals with harbor establishments. The advance which was made in naval technical science during the war was very great.

Before the war we had no efficient mines, and instruction in mining was neglected; there was no system of minesweeping or of protection against mines as we now understand it; the various methods of submarine searching and attack had not been explored; the torpedo as a weapon was unreliable. The reason for this unsatisfactory state of affairs it is unnecessary to consider in this statement, but war experience has shown conclusively that if in times of peace we neglect development of these devices and instruction in their use, years of effort and vast expenditure are required to make good that neglect.

14. As a consequence, therefore, while it is desirable that we should keep down to bare minimum requirements the size of the sea-going fleets, it is essential that the navy should possess all information concerning the

latest scientific devices and their use; that in the event of war the sea-going fleet should be equipped with the best weapons modern science can provide; that there should be a personnel fully trained in technical science, and that the arrangements should be such that rapid expansion can take place both in equipping the reserve fleet and auxiliary units, and in training the reserve personnel for manning these units. For this purpose it is necessary to provide

(a) Adequate experimental establishments for the development of the latest scientific devices in accordance with the requirements of the Staff.

(b) Training establishments where the personnel will be fully instructed in the same.

(c) Light cruisers, destroyers and other attendant craft for carrying out practical experiments with the devices developed by the scientific establishments and for giving practical instruction in their use to the personnel.

(*e*) *Scientific Research.*—15. The organization of scientific research within the navy which has been set up so as to ensure that the latest developments are understood by the naval service, and that development both in types of vessels and in weapons will keep pace with scientific progress, is given in Appendix II to this memorandum. Under the Controller of the Navy there has been set up a department of scientific research and experiment. As the scientific adviser of the controller, and in charge of this department, there has been appointed a director of scientific research who is responsible for the general direction and organization of research work for naval purposes, keeping the navy in touch with outside scientific establishments, and ensuring that the work at the various naval experimental establishments dealing with mining, sound signalling and navigational appliances proceeds with full cognizance of scientific progress and methods. He will arrange for additional scientific assistance being given to these establishments as requisite. Further, the director of scientific research, by keeping in close association with the Naval Staff, will ensure that we are kept fully aware of the possible practical application of scientific progress in relation to naval needs, thus enabling us to formulate requirements as to types and weapons with a knowledge of the latest scientific possibilities, and to make ourselves better equipped for dealing with the vital problems of naval material development.

16. Consultations with outside institutions will be resorted to; so as to gain the benefit of their research and experiments, but there are some problems which it will not be possible to deal with in this manner, owing to their secret or to their special naval aspect. Special naval problems will be dealt with by the naval establishments—gunnery, torpedo, mining, signalling and anti-submarine—but for research work and secret development it is essential that the naval service should have a small central establishment of its own, independent of the special experimental establishments. Such an establishment was formed during the war at Shandon, and has performed, and is performing, good service. But Shandon is expensive to the country in its upkeep, and suffers from dissadvantage in position both in regard to its distance from the naval ports and from the Admiralty, with the consequent liability that owing to insufficient co-operation and contact with naval thought, the research work may be conducted without the necessary consideration for practical requirements.

17. It has been decided, therefore, to close Shandon as soon as suitable accommodation can be provided elsewhere. Such work at Shandon as requires sea environment will be removed to existing naval establishments. All pure research work now being carried out at Shandon will eventually be transferred to a small naval institute adjoining the National Physical Laboratory at Teddington. This institute, under the director of scientific research, will be entirely controlled by the Admiralty, but its close association with the National Physical Laboratory will offer exceptional facilities for co-operation, and the scientific staff of the institute will have the

advantage of personal acquaintance with the work being carried out in the laboratory. It is hoped to have this establishment ready at the end of the present year; meanwhile Shandon, on a reduced scale, is being kept going until the establishment at Teddington is ready. To stop pure research work altogether at this moment would be a retrograde step, and might conceivably have a serious effect ultimately on development of types and weapons, and on economy generally.

(*f*) *Technical Training.*—18. For the technical training of the personnel special schools are established at the naval ports of Portsmouth, Devonport and Chatham. The schools at Portsmouth are the largest, and attached to each of these schools is an experimental establishment dealing with the work of the school. This general system was in existence prior to the war, except that the experimental establishments were practically non-existent. As a result of the war, however, and of the progress in scientific and technical thought, large increases became necessary, especially in the establishments at Portsmouth.

19. As already stated, mining was considered in pre-war days to be a minor and unimportant branch of naval warfare; the staff dealing with this subject was small, and was attached to the torpedo school.

The utility of mines was emphasized early in the operations of 1914, and the science of mining gradually assumed a position of extreme importance in naval strategy and tactics. On the tactical side as well as on the scientific and material side immense strides were made. This called for staff and technical knowledge of the highest order, and necessitated the setting up of a special mining school at the Gunwharf, Portsmouth. This school, though it started late in the war, finally achieved great results, both on its experimental and instructional side. It is essential to keep this school in being.

The mining school at Portsmouth represents an additional establishment for which there was previously no provision. At this school the personnel will be instructed in the science of offensive and defensive mining, and also in devices for protection against mines, including the Paravane.

20. Apart from mining, the torpedo and electrical, and signal schools have all had to be expanded to meet modern requirements. The war was responsible for tremendous developments, and all these developments have necessitated more advanced instruction for the personnel, and an increased staff to give this instruction. More highly organized scientific and experimental establishments have to be attached to the schools.

21. Another technical branch of the naval service, which did not exist when the war was commenced, is the anti-submarine school; the importance of this school in the future can hardly be over-estimated. We have seen the great effort which was made by means of the submarine to wrest from us our sea supremacy. Science alone can give us the antidote to the submarine, and we have taken steps, as will be seen in the detailed statement regarding the fleet, to ensure progress in experimental work and training. Development in this work will undoubtedly be required to meet the possibilities of the future, and proposals are under consideration for the establishment of a school of anti-submarine work in conjunction with an anti-submarine experimental station.

22. The submarine training establishments themselves have, as a result of the war, become more, rather than less, important. Future developments in the submarine may have a profound effect on naval strategy and tactics. This subject is receiving continuous attention. Experimental work is being pressed forward, and in addition adequate steps are being taken to ensure that the high standard of the submarine personnel is maintained. The necessary staff and the attendant vessels shown in Appendix I have been allotted with this purpose in view.

23. It must be emphasized here that the policy with regard to instructional establishments generally has been to ensure the provision of an

adequate experimental and instructional staff, and of the appliances and sea-going tenders required for carrying out the experimental and instructional work with efficiency.

(*g*) *Personnel.*—24. It is upon the efficiency of the personnel that everything finally depends, and the Board of Admiralty are taking such steps as will ensure a naval service carrying on the traditions of the past, highly trained in staff and technical work, and will continue to do all in their power to secure conditions which will combine efficiency and contentment.

(*h*) *Entry and Training of Officers.*—25. First, as regards the officer personnel, it is proposed to adhere to the system known as the common entry system, by which is meant that the main body of deck officers and engineering officers will be trained in the same cadet establishment. The common entry system was the system introduced by the Board of Admiralty in 1903, but since its inception it has undergone many modifications, and in explanation of the present policy it is desirable to give in brief outline the existing state of affairs.

26. Whereas in the past there have been two colleges for the training of naval cadets, it is now proposed that there be only one college at Dartmouth, and that the Osborne establishment shall be closed.

One college is capable of dealing with the reduced number of cadets required for the present fleet, and economy will result from the change.

27. The age of entry for naval cadets under the common entry system will be between 13½ and 14. Consideration has been given to the question of entering boys at a later age, but it has been decided to adhere to the present age as being that at which the majority of boys finish their private school education, before proceeding to public schools.

These boys will go to Dartmouth College, which will in effect be the naval public school where general education on naval lines will be continued under a system of education somewhat changed from that under which the common entry system has hitherto been conducted in that more attention will be paid to general education, and the large amount of time which was previously devoted to engineering will be reduced. The important factor at the cadet college is to ensure that the boys have a thorough groundwork on which to build.

28. The cadets will spend four years at Dartmouth and will then be sent for two terms (8 months) to a training battleship for their practical education and for gaining acquaintance with sea life, afterwards being drafted to sea as midshipmen. As midshipmen they will take their part as officers of the ship to which they are appointed, but their instruction will continue, the majority of their time being spent on their work as deck officers and one-eighth being devoted to engineering.

After one year at sea, those midshipmen who show a special aptitude and liking for engineering will be permitted to volunteer for that branch of the service; such midshipmen will thereafter devote one-third of their time instead of one-eighth, as hitherto, to engineering.

29. On reaching the rank of sub-lieutenant a further opportunity will be given to officers to volunteer for the engineering branch of the service, and from these volunteers and from those who volunteered as midshipmen selections will be made. It may be expected that the majority of officers selected will be from those who volunteer for engineering after serving one year at sea as midshipmen, and who since that time will have devoted a considerable portion of their time to engineering studies.

Officers selected for the engineering branch when sub-lieutenants will, after going through advanced courses of engineering, be definitely placed on the engineering side of the profession, and will not revert during the remainder of their career to deck duties. They will rise through the various ranks of the engineering branch, with special rates of pay. Higher positions of administrative importance and responsibility at sea, at the Admiralty, and in the dockyards will be open to them.

30. It requires to be emphasized that officers selected at this early age will devote the remainder of their career to engineering. It is essential that the majority of officers forming the engineering branch should be "whole time" officers. There is a definite distinction, both as regards knowledge and capabilities, between those who are to be trained in the science of naval war and strategical and tactical methods of fighting, and those who are to deal with the upkeep and maintenance of engineering and mechanical appliances which are necessitated by the complex machinery and weapons of modern war. Each side requires a special study, and for this reason final separation of the branches is essential.

31. At the same time, although there must be this definite division between the deck and the engineer officers, each being charged with their own important sphere of responsibility, nevertheless, each branch must understand and sympathize with the requirements of the other. In the exercise of strategy and tactics it is necessary that there should be full understanding of the engineering and mechanical possibilities and difficulties, and how such difficulties can be overcome. On the engineering side it is equally necessary that there should be an understanding of the requirements of the strategist and tactician, in order that so far as practicable his requirements may be met and perhaps anticipated.

By means of the Common Entry System and training under a similar system until about the age of 20, when the rank of commissioned officer is reached, it is believed that this sympathy and understanding between deck and engineer officers will be fully and completely obtained.

32. At present there is a further scheme whereby officers, after one year at sea as lieutenant, are eligible to specialize in engineering in the same way as officers specialize in gunnery, torpedo and navigation.

After from 6½ to 8 years' service as specialists these officers may elect to revert to deck duties and will be considered for promotion with other deck officers. The efficiency of this scheme, and the necessity for its continuance, is now under consideration, and will be decided without prejudice to officers already specialized under its provisions.

33. Briefly, therefore, the system of general training as an officer will be:

(a) Common Entry System at about 13½ years of age.

(b) Three years eight months (11 terms) training at Dartmouth.

(c) Eight months in a training battleship.

(d) About 2½ years at sea as midshipman before becoming a sub-lieutenant.

(e) Midshipmen, after one year at sea, to be permitted to volunteer for engineering and to be given special engineering instruction.

(f) Sub-lieutenants to be permitted to specialize in engineering; officers selected to be turned over to the engineering branch, and to stay for the remainder of their career in that branch.

(g) Promotion to lieutenant after serving about one year as sub-lieutenant, that is about the age of 22.

(h) Lieutenants, after one year to be permitted to specialize in engineering, such lieutenants to remain from 6½ to 8 years in the engineering branch, and then to be permitted to return to the deck branch or to remain in the engineering branch. (Continuance now under consideration.)

(i) Promotion to lieutenant commander after 8 years as lieutenant, about the age of 30. Further promotion at approximately the ages and seniorities hitherto customary.

34. Although, as explained in the foregoing, it is the intention that the general age of entry shall be about 13½ years, and that boys so entered shall be sent to Dartmouth, it is highly desirable in the interests of the naval service that there shall be a special form of entry at a later age, so that boys who are not ready at the age of 13½ may still have an opportunity of entering the naval service, and also so as to allow of a certain number of public school and other boys coming into the service, and thus keeping

the navy in touch with the general educational system of the country. To permit of this, it has been decided to continue what is known as the Special Entry System, that is, a competitive examination between the ages of 17½ and 18½.

35. About 15 Special Entry cadets will be taken under existing circumstances annually; these cadets who will already have received a general education, will be drafted to a cruiser training establishment, there to learn the special subjects required, and to gain an understanding of the sea. After one year in the training cruiser these cadets will be sent to sea as midshipmen, joining up with the Common Entry midshipmen, and thereafter being trained on exactly similar lines. Their time of service as midshipmen will be adjusted so that on reaching the rank of lieutenant, Special Entry cadets will as a whole be not more than one year older than those entered through Dartmouth College. This year's difference in age will make little or no difference to an officer showing zeal and ability; promotion to the rank of commander and captain being by selection, this year can be more than made good, and, in respect of a subsequent career, boys who enter under special entry conditions should understand that they suffer no disadvantage as compared with those entering through the main channel.

(*j*) *Promotion from the Lower Deck.*—45. The foregoing gives the general system under which deck and engineer officers for His Majesty's service will be entered and trained. There remains to be considered the system of promotion from the lower deck, which is being devised to ensure that men who display conspicuous character and ability shall have the opportunity of reaching the highest ranks of the service.

46. At present, under the regulations of the special entry examination, a man from the lower deck between the ages of 17½ and 18½ can sit for this examination, and, if successful, he will become one of the special entry cadets in the ordinary course of events. But owing to the lack of early educational facilities and also to the specialized training received since joining the naval service, as boys, to the detriment of their education in such examination subjects as French and Latin, it is certain that only a small percentage of men could possibly take advantage of the special entry system. Some other system, therefore, than the special entry system must be looked to in order to give the lower deck of the navy the opportunity of reaching high rank, and to enable us to draw a proportion of officers from those who entered as boys on lower deck.

47. The present "mate system," whereby selected petty officers, provided they have seven years' service, are promoted and receive commissions as mates, and after a series of examinations and further service of two years become lieutenants, was designed to form an avenue of promotion from the lower deck, to the commissioned ranks. Many admirable officers have been produced in this manner. But the mate system has suffered from the disadvantage that, owing to the operation of the seven years' service rule, the majority of men promoted to commissioned rank in this manner do not reach the rank of lieutenant until 28-29 years of age or even later. When it is considered that an officer entering under normal conditions reaches the rank of lieutenant at about 22 years of age, it will be seen that under this system there is little chance of a man promoted from mate reaching a higher rank than lieutenant commander.

48. To remedy this state of affairs, and to give a real opportunity to all men, a certain number of vacancies in each year will be available for men from the lower deck who may wish to become officers.

A man on reaching the age of 21, provided he has satisfied the requirements of a Sea Selection Board and has passed the seamanship examination for officer's rank, and has further taken a first-class certificate in the special educational test, embracing mechanics, geometry, history, physics, and general subjects, will be eligible for selection before an Admiralty Selection Board. Those selected to fill the vacancies available will become

acting mates, the earliest age being 21. Provided a man takes a first-class certificate in the further special course he will undergo, he can become a lieutenant at the age of 23. Candidates who take lower class certificates will be required to serve a longer period at sea before promotion to lieutenant, the same procedure being followed in this respect as with Dartmouth College or special entry officers passing for lieutenant.

49. A man, therefore, who takes a first-class certificate, can be promoted to lieutenant at about the same age as a special entry cadet can reach that rank. He will then be on a precisely similar footing to other lieutenants with regard to promotion, the highest ranks being within his reach.

50. In connection with this development of the mate system, it is intended that those candidates who have been selected shall go through a special course designed to inculcate into them the essential requirements of an officer—knowledge of discipline, maintenance of morale and capacity for command of men; hitherto, men promoted from the lower deck have not had such a course. War experience has certainly shown the necessity for it, and in this respect the navy cannot do better than adopt the methods so successfully practiced by the sister service, which, as explained by the Secretary of State for War, during the last months of the struggle produced 95 per cent of the officers for the army.

51. The above gives briefly in outline the proposals of the Board of Admiralty for ensuring that a proportion of the deck officers of the navy shall be drawn from the boys establishments and from those who have served on the lower deck. An analogous system is being applied to the engineering branch as well; it will ensure to all the opportunity which is their right, or reaching a high rank in His Majesty's service.

52. It is not, however, the intention to rest here; it is hoped in the future to make further proposals with the object of broadening the field of entry and of removing the restrictions which financial contributions impose upon the promising lad who may display the qualities necessary in an efficient naval officer.

(*k*) *University Training of Naval Officers.*—53. There remains to be considered the higher education of the officers of His Majesty's service. Before the war this education was almost entirely professional and technical. Officers in their sub-lieutenant's examination were required to pass examinations in various technical subjects. Later, they specialized in gunnery, torpedo, or navigation, and went to special schools for this purpose, where their higher technical education was completed.

54. The whole of this question of higher education has been carefully reviewed in the light of war experience, and it appears that though the former system gave a type of officer of high professional attainments, yet, in many respects, it has left considerable room for improvement, the nature of the courses being rather too strictly professional and technical. Consequently, in certain respects, the naval officer was at a disadvantage as compared with his contemporaries in other walks of life, who had had the advantage of a more general education, and had come into contact with all shades of thought up to a comparatively late age.

55. The effect of the war was, in the case of the younger officers, seriously to interfere with their actual general education at the Osborne and Dartmouth colleges prior to coming to sea, nor was it possible, in the case of a large number of officers, to arrange for the special courses prior to their becoming lieutenants. At the close of the war, therefore, these officers found themselves at a serious disadvantage; first, from the interruption of their general education, and, secondly, from the fact that they had been unable as sub-lieutenants to pass through the courses at Greenwich College and the various naval schools.

56. To remedy this state of affairs, the authorities at Cambridge University were approached. The university authorities showed the greatest sympathy and gave us the most generous assistance, and as a result all those officers who had their studies interrupted by the war are being given

a special course at Cambridge University. This course is designed to broaden the outlook on life and to bring officers into contact at an impressionable age with university thought and university ideas. It will not be until 1922 that all officers who had their studies interrupted will have been through Cambridge; meanwhile, we are convinced of the enormous benefit which has already resulted to those officers who have been through the course. We are grateful in the extreme for the help which has been given; it has shown the value to the navy of this contact with the university, and it would be a profound mistake if this contact ceased so soon as the officers concerned have passed through their courses.

57. It is in contemplation to frame a scheme subject to the concurrence of the university authorities, under which in the future a university course will be an integral part of training for about 25 per cent of the sub-lieutenants in each year. It is considered that about this percentage will gain real and lasting benefit from the course.

58. The full details of this scheme of training will be worked out during the coming months. Broadly, the proposals are that all sub-lieutenants shall undergo, in addition to the technical courses of gunnery, torpedo, pilotage, and navigation, a special course of mathematics and physics, and an elementary war course at Greenwich. In this elementary war course, to which great importance is attached, sub-lieutenants will be given an introduction to strategy, tactics and the study of war. After Greenwich 25 per cent will be selected for the special university course, the remainder passing to sea-going ships prior to promotion to lieutenant.

(*l*) *Staff Training.*—59. In the interests of the future of the service, great importance attaches to the selection and training of officers for the War Staff. A body of officers is required who have made special study of the lessons of history and of the war, and who are capable of sifting and applying the mass of evidence available.

60. Reduction of the navy to the utmost limit in ships and material makes it the more important that the efficiency of the War Staff shall be of the highest order, and that during the forthcoming years there shall be passed through the Staff College a number of young officers whose training in staff work will ensure a common doctrine on strategical and tactical questions, the right application of the lessons of the past, and the ability to foresee the requirements of the future.

61. With this end in view a Naval Staff College has been set up at Greenwich. The first course commenced in June last and will be completed in June of the present year. In the next course commencing in September, the number of officers will be increased and will, it is hoped, include representatives from the Dominions.

62. We must aim at training at least 40 naval officers a year, so that in 10 years 400 will have qualified for the Naval Staff and will be distributed through the various grades of the naval service. It is further highly desirable that the number of army, air force, and Dominion representatives attending the Naval Staff College should be increased to ensure close co-operation between the services, and to build up the naval thought of the Empire on the common doctrine on which the navy must prepare itself. To carry this out it will be necessary to consider methods of increasing the Staff College accommodations; this matter is receiving serious attention, and it is hoped that a decision will be reached in time to enable the staff course in 1921 to be of the dimensions proposed; the matter will be referred to in the Naval Estimates of 1921-22.

63. For the benefit of senior officers who are unable to take advantage of the Staff Course, a War College has been opened at Greenwich and a special staff appointed for instructional purposes. Strategy, tactics, and command are the principal subjects dealt with. The course at the War College will be preceded by technical courses at Portsmouth dealing with the use of weapons and progress in weapon technique. The War College at Greenwich opened on 1st of March.

(m) War Staff Organization, Admiralty.—64. As it exists today the War Staff at the Admiralty, it is correct to say, is largely a war product. Before the war the Staff consisted of the Intelligence Division, Operations Division, and Mobilization Division. No "policy" or "planning" division had then come into being, and no division of the Staff dealt with the tactical side of naval war, types of ships, and use of weapons. The exigencies of war brought about an expansion of the Admiralty including the divisions dealing with the operations and requirements of war, and emphasized the need for separating operational worn on the one side from the work of administration and supply on the other. The reforms were carried out by the Admiralty under war conditions, and as a consequence certain logical divisions of duty in the Naval Staff organization could not be effected.

65. The main consideration on which we have worked in improving the Admiralty Staff organization has been to strengthen that side of the Staff which deals with the use and employment of weapons, the tactical questions consequent on change of weapons, types of vessels necessary to carry out naval policy, and staff questions dealing with scientific research and experiment. The staff view on these matters must be kept in the forefront, otherwise there is the danger that requirements of design and supply will dictate the principles relative to use and employment, resulting in the weapon become the master and not the servant of the tactician.

66. The war has enabled us to test the weapons forged during a century of peace, and has shown that some of them were unsuitable and inadequate. It is clear that the reason they were so was not so much the fault of the design or manufacture, as that the designers are now shown to have been incorrectly or incompletely advised as to the fighting requirements of the moment.

67. In order that progress in naval matériel may be steady, consistent, and well judged, and not impulsive and jerky, it must be based on continuous study and co-ordination of the lessons of war, and of experience and progress of our scattered fleets in their peace exercises and practices. The design of our ships must not and should not depend on the impulse of an individual nor merely on the mechanical possibilities of the moment, though the latter must necessarily limit the immediate accomplishment of our whole aim. Design must primarily depend on closely reasoned "requirements" based on evidence continuously and steadily accumulated from the lessons of our fleets, for whose use the ships and weapons are to be supplied. The aim must, and necessarily will, be provided by the science of the day.

68. The work thus indicated is the work of the Staff, and certain divisions of the Staff are therefore being grouped under the Assistant Chief of the Naval Staff to deal with questions relating to the use of weapons, types and designs to meet future developments, co-operation of aircraft and their employment in naval war, weapon technique and the introduction of new weapons. In fact, the Assistant Chief of the Naval Staff will be responsible under the Chief of the Naval Staff to the First Lord for dealing with all Staff questions affecting battle tactics and fighting efficiency.

69. The divisions of the Naval Staff dealing with operations, policy, intelligence, and training have been similarly placed under the Deputy Chief of the Naval Staff, the accepted principle of organization that current work and future work shall not be dealt with by the same division being closely adhered to. Under the operations division will come all those matters of current importance affecting the movements of ships and defence of ports, whilst the policy division will investigate future strategical questions, strengths of fleets, and development of dockyard and other facilities to meet future requirements, in accordance with the policy laid down by His Majesty's Government.

70. Briefly then the organization of the Naval Staff to meet peace requirements is as follows: At the head of the Naval Staff is the Chief of

the Naval Staff, responsible to the First Lord for the fighting efficiency of the fleet and the strategic and operational instructions to carry out policy. Under the Chief of the Naval Staff the Deputy Chief of the Naval Staff on the one side is responsible for operations, policy, intelligence, and training, and the Assistant Chief of the Naval Staff on the other side is responsible from the Staff side for the development and use of material, including types of vessels, weapons, and tactics.

71. Under this organization war experience will be fully laid to heart and the lessons applied to naval training and naval progress. Further, by these means the Staff is reduced to the minimum numbers compatible with efficiency, whilst at the same time rapid expansion on sound lines is allowed for in the event of emergency. From an organization consisting of ten divisions with a personnel of 340 the new organization will shortly consist of eight divisions with a personnel of about a quarter of that number. They should supply a sufficient personnel to study and apply the results of our experience, and by neglect of that experience there would be real danger of embarking on expenditure on wrong lines, the building of wrong types of vessels, incorrect tactics, and a faulty training of the personnel.

(n) War Staff Organization: Sea Commands.—72. The War staffs in all sea-going commands and at the harbor establishments have been organized on similar principles, with reduced staffs according to the size of the command. As with the Admiralty Staff, it is correct to say that before the war the staffs at sea were only partially developed. There was a tendency for study of the technique of naval weapons to overshadow study of their employment.

73. War experience necessitated a change in these methods, and the division of staffs afloat into War Staff on the one side and a technical and administrative service on the other, is now an integral part of the organization of the navy. As trained War Staff officers are produced they will be appointed in their various capacities to fill the positions in those commands. By interchange between officers on the Admiralty Staff and the commands afloat, and also by arranging that Staff officers are appointed at intervals for general ship duties, leaving their staff work for the time being, it will be ensured that touch is kept between the Admiralty and sea thought and sea progress, and also that the Staff officers themselves do not become divorced from the general sea service, with a consequent narrowness of outlook unable to appreciate through lack of sea experience the various problems in connection with sea training and the personnel afloat.

74. With the system of training and organization of staffs on these lines, it is considered that the high efficiency of the officer personnel is ensured; that unity of thought and action will result from a common staff doctrine, and that the full requirements, present and future, will be met with the greatest efficiency and the greatest economy.

(o) The Navy and the Air.—75. We recognize fully that future naval policy is profoundly affected by possible developments in the air. All classes of aircraft employed as adjuncts to naval warfare have already shown the great effect they exercise in naval tactics and reconnaissance, and in combined operations. Looking ahead, it is possible to foresee tremendous developments in the air which may revolutionize eventually our present conception of sea warfare and sea strategy. But whilst giving the utmost consideration to the experience already gained, it is vital to this Empire that it should not be carried away by hasty proposals into the belief that air power is already a substitute for sea power. That day may come, but it is not at present in sight, and in the meantime to give way to these false ideas would be to throw ourselves open to grave peril and to leave ourselves without the means of exercising that influence in world affairs which the navy, as at present constituted, renders possible.

76. Nevertheless, our organization must be such as to enable us to take full advantage of the progress in aerial matters and to appreciate fully the effect of this progress on the art of naval warfare, and to utilize to

the utmost extent the combined effect of air power and sea power for the defence of the Empire and the control of our sea communications.

77. The new organization of the Admiralty Staff under the Assistant Chief of the Naval Staff is especially fitted for dealing with this vital matter. Arrangements have been made with the Air Ministry for close co-operation between the Admiralty Staff and the Air Staff, and for ensuring that the two staffs are conversant with each other's problems and requirements.

78. To remove all misconception it should be stated with emphasis that we in no way contemplate a return to a separate naval air service. It is recognized that the Air Ministry was created by Parliament as a result of war experience to further the development and maintenance of air power, and that to separate entirely from the Air Ministry that part dealing with the navy would be to retard progress and result in a weakening both in development of matériel and the training of an air personnel.

79. At the same time it is an essential accompaniment of the establishment of a separate Air Ministry that the functions of the two departments should be clearly defined, and more especially is this the case with regard to the responsibilities for the conduct of operations.

The Admiralty have represented to the Air Council, that, in their opinion—

(a) The operations of all aircraft flown from His Majesty's ships and vessels with whatever object in view, that is to say, not only reconnaissance and artillery observation machines, but also machines which are carrying out operations in the air for offensive and defensive purposes; and

(b) All operations carried out by aircraft not flown from ships, but which are being carried out in connection with the command of the sea, that is to say, operations for oversea reconnaissance and for the attack of enemy ships and vessels—

should be under naval control. Dual control would be unworkable. In all matters relating to the command of the sea the Admiralty are and remain the responsible authority.

80. We are working out the scheme outlined in the memorandum by the Chief of the Air Staff issued as Cd. 467, and are in correspondence with the Air Ministry with a view to putting it into effect.

So far as can be foreseen, naval requirements will be met by the proposal ultimately to form a naval wing under the Air Ministry, with a personnel specially trained for naval work.

81. To assist in the development of this naval wing, it is proposed to second officers volunteering for air work in the air service for training and for subsequent service in the naval wing. Such officers as are specially fitted for work in the higher ranks of the Air Service will, by arrangement with the Air Ministry, be permitted to continue in the Air Force, but the majority of officers after their term of service in the Air Force will return to the naval service and continue their naval duties. Thus in the course of a few years there will be a body of naval officers who will have had experience in the Air Service, who will be equipped with knowledge regarding air matters, and who will be able to keep the navy as a whole fully up-to-date in regard to air strategy and air tactics in relation to sea power.

82. Thus by seconding naval personnel to the Air Force, by an interchange of naval and Air Force officers between the Staff colleges, and by the special organization of the Naval Staff, the naval service will be prevented from falling behind in air matters through lack of foresight, through ignorance, or through a conservatism which refuses to understand the necessity of change consequent on development.

(*q*) *Miscellaneous Personnel Questions.*—(I) Officers of Accountant and Instructor Branches: 84. The committee which was appointed in July last, with wide powers of reference, to consider the position as regards the accountant branch is on the point of making its report. As soon as the report is received, the question of the future conditions of

service and scope of employment of the branch will be fully considered by the board.

85. The instructor branch, which was being allowed to die out before the war, is being reconstituted on a wider basis. The instructor officer is being made responsible for the general education arrangements afloat, apart from work of a purely professional character, both as regards junior officers and ratings. It is anticipated that, apart from the advantages of having an officer of special university training on board, naval education generally will derive benefit from the change.

(II) Welfare Committee: 86. A new experiment was made by the Admiralty last year in the shape of what is known as the welfare committee. Special facilities were given to enable full discussion to take place at the home ports on matters affecting the different branches of the service and the lower deck generally. Subsequently representatives elected by the men themselves were attached in an advisory capacity to a committee of officers, and a very large number of questions were brought forward and discussed at a series of meetings extending over several months. The report of the committee, which is very voluminous, was made on the 3d March. Any changes which are decided on after consideration of the report will be promulgated to the fleet in the usual manner. We attach great importance to the operations of this committee, and we hope that, with sympathetic consideration, they may lead to many improvements in matters affecting the well-being of the men.

The Board of Admiralty are much indebted to Admiral Sir Martyn Jerram for the care and sympathy with which he has presided over the deliberations of this committee, in continuation of the work he had previously done in connection with the pay of the lower deck.

(III) Sports and Recreations: 87. A special section has been set up at the Admiralty to supervise physical and recreational training in the service. It is also part of its duty to promote the organization of sports and games, and with this end in view a sports' control board has been set up at the Admiralty, and various sports associations and local sports committees have been formed.

(IV) Reserves: 88. The question of the naval reserves has not yet been finally dealt with.

A committee is considering alterations in the existing arrangements for enrollment, training and employment, and the organization for rapid expansion on the outbreak of war.

It is therefore not possible to make any announcement at present, but the importance of early decision is recognized and the matter will be pressed.

For the moment it may be sufficient to say that the reserves have fully proved their value during the war, and that it is intended to retaain them as part of our peace organization.

NOTE ON DOCKYARD POLICY.—The report of Lord Colwyn's committee on work in His Majesty's dockyards having been presented to Parliament, I take this opportunity of adding a few words in explanation of the present situation in the yards.

Before the war the home dockyards were six in number, viz., Portsmouth, Devonport, Chatham, Pembroke, Sheerness and Haulbowline, and the number of men employed on shipbuilding and repair work was about 42,000.

We now have seven home dockyards, the great and finely-equipped dockyard of Rosyth having been completed during the war.

The number of men employed on shipbuilding and repair work in the home yards at the time of the armistice was 67,800.

This great increase was necessary in order to deal with the urgent repairs of the fleet, which had to be carried on practically continuously day and night, by means of double shifts, etc.

The increase was mostly in the engineering trades and in semi-skilled and unskilled labor, and these classes at the time of the armistice were necessarily out of proportion to the numbers of shipwrights and allied trades.

In the months immediately succeeding the armistice, a large amount of urgent work, in fitting out ships for their foreign stations and in connection with the reconditioning of mercantile vessels temporarily added to the navy during the war, devolved upon the dockyards and kept practically all hands employed.

When this work began to fall off, it became necessary to consider the reduction of dockyard numbers to a normal peace establishment, in fixing which the effect of the existence of the new yard at Rosyth in drawing away work from the southern yards had of course to be allowed for.

It was decided to effect the necessary reduction in numbers as gradually as possible by a system of regular weekly discharges, preceded by a fortnight's notice, so as to enable men to get employment in the merchant shipbuilding yards, where the need for additional labor was stated to be urgent. Experience soon showed however, that the merchant shipbuilding yards only absorbed a small number of the men so discharged. This was largely due to the impossibility of finding married accommodation in the commercial shipbuilding centers, but partly also to the fact that the surplus dockyard men belonged chiefly to the engineering trades and to semi-skilled and unskilled classes, whereas the urgent demand in the merchant shipbuilding yards is for shipwrights and allied trades. Considerable numbers of shipwrights who could ill be spared from the dockyards were set free in the autumn so as to relieve the shortage in the merchant shipbuilding yards, but this was done at a cost of still further disarranging the proper balance of trades in the dockyards, and has added to our difficulties.

In these circumstances His Majesty's Government decided that the discharges from the dockyards should be reduced to a minimum during the winter, and naval work that was originally intended to be deferred until a later date was brought forward, so as to keep as large a number as possible employed during the winter months.

Simultaneously, the committee, under the chairmanship of Lord Colwyn, was set up to advise on other ways of tiding over the emergency, and has made the valuable report which has recently been laid on the table.

In pursuance of the recommendations of the committee, the Admiralty are taking steps to lay down an oil tanker at Devonport immediately, and a second mercantile ship will be laid down at Pembroke at a very early date. It has been decided, in view of the difficulties of the present situation, not to proceed further with the proposal to lease the latter yard. There is no slip at present available at Portsmouth, and one will not become available there until late in the year, but the question whether a dock could be utilized at an earlier date for laying down a third mercantile ship is under consideration. A slip is available at Chatham, but the amount of urgent naval repair work employing shipwrights is so large, and the disproportion of trades is so great, that we could not at present start a merchant vessel there without drawing away shipwrights from the commercial yards, a procedure which would not be in the interests of merchant shipbuilding at the present time. Any further opportunities, however, of taking in hand work such as is contemplated in the committee's report will be carefully watched for and utilized.

Whilst these measures will undoubtedly mitigate to some extent the severity of the reductions that will have to be reintroduced after the end of this month, I wish to make it clear that, in spite of all that has been done and all that can be done, very heavy discharges will have to be made during the year 1920-21. After the most careful consideration the Board are unable to suggest any alternative means of at once meeting the pressing demand for public economy and remedying the serious disproportion of trades in the dockyards.

In the concluding paragraphs of the preceding statement on naval policy, I have made it quite clear that, in the interests of public economy, the Board are keeping down naval repair work and other dockyard services to as low a figure as is possible during 1920-21. It will, of course, be pointed out to me that the effect of this policy of economy is to increase the discharges during the same period. It is perfectly true that there is the possible alternative of spending a great deal more money in the dockyards that in this way we could make it necessary to employ more men. But to resort once more to this process of bringing forward work which would otherwise fall on a later year could only prolong for a short time the maintenance of the present abnormal conditions in the dockyards, and would necessarily be followed by an even greater and more sudden reduction in numbers, at a time, probably, when the present intense activity in commercial shipbuilding will have abated, and when consequently the difficulties of absorption in outside industry would be increased.

APPENDIX I

FLEET ORGANIZATION

ATLANTIC FLEET

Fleet Flagship	*Queen Elizabeth.*
1st Battle Squadron	*Revenge* (flagship).
	Resolution.
	Ramillies.
	Royal Oak.
	Royal Sovereign.
2d Battle Squadron	*Barham* (flagship).
	Valiant.
	Malaya
	Warspite.
Battle Cruiser Squadron	*Hood* (flagship).
	Repulse.
	Renown (on detached duty).
	Tiger.
1st Light Cruiser Squadron	*Delhi* (flagship), *Dunedin, Danae, Dauntless, Dragon.*
2d Light Cruiser Squadron	*Caledon* (flagship), *Carysfort, Cleopatra, Cordelia, Coventry.*
Destroyers	*Castor* (light cruiser), 2 depot ships and 4 flotillas, consisting each of 2 flotilla leaders, and 16 destroyers.
Submarines	*Inconstant* (light cruiser), 3 flotillas of 7 boats each, with necessary depot ships and tenders.
Aircraft Carrier	*Argus.*
Battleship for Fleet Gunnery Service	*Agamemnon.*
Minelayer	*Princess Margaret.*
Trawlers, Drifters, and Tugs.	As necessary for Fleet work.

MEDITERRANEAN

4th Battle Squadron.....*Iron Duke* (flagship).
Emperor of India
Marlborough.
Benlow.
Centurion.
Ajax.
3d Light Cruiser Squadron..*Cardiff* (flagship), *Ceres, Caradoc, Calypso, Concord, Centaur.*
Destroyers .....1 flotilla, consisting of 2 flotilla leaders, 16 destroyers, and 1 depot ship.
Aircraft Carrier .....*Pegasus.*
Special Service Vessel .....1.
Danube Force .....3 river gunboats and 6 motor launches.
Red Sea .....2 sloops.

CHINA

Flagship .....*Hawkins* (light cruiser).
5th Light Cruiser Squadron..*Cairo, Carlisle, Curlew, Colombo.*
Submarines .....1 flotilla of 12 boats and 2 depot ships.
Sloops .....4.
Gunboats for river work ....14.
Aircraft Carrier .....*Ark Royal.*
Special Service Vessel .....1.

AFRICA

6th Light Cruiser Squadron ..*Birmingham* (flagship), *Dublin, Lowestoft.*
Sloops .....2.
Gunboats for river work .....2.

SOUTH AMERICA

7th Light Cruiser Squadron..*Southampton* (flagship), *Yarmouth, Dartmouth, Weymouth,*
Sloop .....1.

EAST INDIES

4th Light Cruiser Squadron..*Highflyer* (flagship), *Caroline, Comus.*
Sloops .....3.
Special Service Vessel for Persian Gulf .....1.
River gunboats for Tigris and Euphrates .....2.

NORTH AMERICAN AND WEST INDIES

Flagship .....*Raleigh* (light cruiser).
8th Light Cruiser Squadron..*Calcutta, Calliope, Constance, Cambrian.*
Sloops .....2.

NEW ZEALAND

Sloops for South Sea Islands.

LOCAL DEFENCE FLOTILLAS

Portsmouth .....4 destroyers.
Chatham .....4 destroyers.
Devonport .....4 destroyers.
Firth of Forth .....4 destroyers.
Coast of Ireland .....1 sloop and 6 destroyers.
Gibraltar .....4 destroyers.
Malta .....4 destroyers.

SURVEYING SHIPS

Home Service .....6.
Foreign Service .....4.

PATROL, MINESWEEPING, TRAINING, AND FISHERY PROTECTION SQUADRON

3 sloops, 7 twin-screw minesweepers, and 10 trawlers have been detailed for this service.

TRAINING AND EXPERIMENTAL ESTABLISHMENTS

GUNNERY SCHOOLS

Portsmouth .....1 cruiser, 1 light cruiser, 1 destroyer.
2 trawlers, 1 motor launch, 1 tug.
1 diving tender, 1 monitor.
Chatham .....1 battleship, 1 monitor, 1 destroyer.
1 trawler, 1 motor launch, 1 diving tender.
Devonport .....1 cruiser, 1 monitor, 1 destroyer.
1 trawler, 1 motor launch, 1 diving tender.

TORPEDO SCHOOLS

Portsmouth .....1 light cruiser, 4 destroyers, 4 "P" boats.
4 trawlers, 2 drifters, 2 motor launches.
Chatham .....2 destroyers, 1 trawler.
Devonport .....2 destroyers, 1 trawler.

SIGNAL AND W/T EXPERIMENTAL ESTABLISHMENT

1 cruiser, 1 destroyer, 1 "P" boat, 1 whaler.

SEAGOING GUNNERY SHIP FOR QUALIFYING GUNLAYERS

1 battleship, 1 tug, 1 motor launch, 1 drifter.

NAVIGATION SCHOOL, PORTSMOUTH

3 twin-screw minesweepers.

CADET TRAINING

Seagoing Training Ships .....1 battleship, 1 cruiser.
Dartmouth College .....1 destroyer, 1 patrol gunboat, 1 motor launch.
Osborne College .....1 torpedo boat.

ANTI-SUBMARINE TRAINING

Portland .....1 depot ship, 4 "P" boats, 1 whaler, 1 drifter.
Shandon .....3 trawlers, 2 motor launches.

SUBMARINE TRAINING

Periscope School (Portland)	1 depot ship, 1 sloop, 1 launch, 4 submarines.
Submarine School (Portsmouth)	2 depot ships, 1 sloop, 1 motor launch, 2 launches, 6 submarines.

RESERVE FLEET

Rosyth	3 battleships, 7 "P" boats, 8 submarines.
	4 battleships, 3 battle cruisers.
Chatham	1 aircraft-carrier, 5 submarines.
	4 light cruisers, 1 flotilla leader.
Devonport	18 destroyers, 2 depot ships, 1 repair ship.
Portland	1 battleship, 3 light cruisers, 2 flotilla leaders, 16 destroyers, 1 depot ship, 1 monitor.
Portsmouth	2 battleships, 3 light cruisers, 2 flotilla leaders, 15 destroyers, 1 depot ship.
	6 submarines (attached to *Dolphin*).
	32 submarines (laid up).
Central Reserve of Twin-screw Minesweepers	42 (including 3 employed with training establishments).

APPENDIX II

ORGANIZATION TO SECURE FOR THE NAVY THE FULL ADVANTAGE OF SCIENTIFIC RESEARCH AND ADVICE.—To ensure that the full benefits of science shall be secured to the naval service, a department of scientific research and experiment has been constituted under the Third Sea Lord and Controller.

2. This department is under the charge of a specially selected scientist—with the title of director of scientific research—who will be responsible to the Controller for the general direction and organization of research work for naval purposes, and will work in close association with the naval staff.

3. It will be the duty of the department under the director of scientific research—

(a) To keep under constant review the progress in scientific knowledge at the universities and in all government and civil departments, institutions and establishments, in this and other countries, where research work is being carried out;

(b) To investigate all new scientific principles and developments thus brought to light, with the object of ascertaining whether they are likely to prove of value to the naval service; and

(c) To act as the normal channel through which outside scientific institutions and workers may be approached with a view to their undertaking research work for naval purposes.

4. The department will also maintain close association with the scientific work being undertaken in the various naval experimental schools, and it will be the duty of the director of scientific research from time to time to visit these schools, both to ensure that development of new or improved methods does not proceed without full consideration of the latest scientific discoveries that may bear upon the problems in hand, and to satisfy himself that scientific methods are being utilized to the most profitable extent.

5. Whilst it is only by the fullest exercise of the policy of "farming out" of problems that overlapping of work will be obviated and expense saved, especially in matters involving chemical research, there will always remain certain problems of especial importance to the navy and maritime world generally, for the solution of which no appropriate outside agency will be readily available. Thus, it is essential that the Admiralty should

possess some suitable establishment of its own. The complete equipment of the necessary laboratory near London would, however, entail considerable expense, and would, moreover, be wasteful in that the valuable installations would, in general, not be used to their full capacity. It has therefore been decided to provide what, in the circumstances, is considered to be the best and most economical method of meeting naval requirements, namely—to establish a naval research institute of moderate dimensions adjoining the National Physical Laboratory at Teddington. While this institute will be entirely controlled by the Admiralty, its close association with the National Physical Laboratory will offer exceptional facilities for research, and the scientific staff will gain the additional advantage of personal acquaintance with the work being carried out in that laboratory. Doubtless also arrangements can be made for the existing power, lighting, etc., plants at the National Physical Laboratory to be made available for the use of this naval adjunct.

6. The organization now proposed is also necessary for the purposes of an arrangement whereby, when required, scientists will be lent to naval experimental establishments for particular work, such as—

(a) Fundamental research work requiring sea environment.

(b) Assisting in the early stages of adapting some new scientific discovery to practical service use.

7. Further, a naval research institute is essential if the scientific work of the department is to remain of the highest order obtainable. It is a common experience among scientific workers that the ideas which mark real progress come during actual work with their own hands, and for this reason, in addition to those already set forth above, a laboratory is necessary wherein the scientific staff may work, and where the director of scientific research may personally investigate such problems as he, by training and experience, is specially fitted to undertake.

8. At present there exists a laboratory at Shandon. This establishment was set up during the war with the primary object of investigating methods of counteracting the enemy's submarine menace. The site was originally chosen on account of its proximity to deep water and of other facilities, but recent developments have shown that the limited and land-locked waters of the Gare Lock, and the distance from the open sea, render Shandon not well suited to the requirements of naval researches.

Apart, however, from its local imperfections, a great objection to the permanent retention of Shandon as the naval research institute lies in its great distance from the experimental schools, the various scientific institutions and the Admiralty, which latter must remain the center of control of scientific work for the navy.

9. It has accordingly been decided that so soon as suitable accommodation can be provided elsewhere Shandon is to be abandoned, such work as requires sea environment, together with the scientific personnel associated with it, being removed to a suitable existing naval school, and the remainder, which does not in its early stages require such surroundings, being transferred eventually to the naval research institute.

10. It will be admitted by scientists that their enthusiasm may render them liable to pursue some particularly promising line of research that is revealed in the course of their investigations, and although no doubt of value in the general interests of science, the results may have no particular bearing on the solution of problems likely to be of benefit to the navy. On occasions it may be wise to "give the scientist his head" if, as is essential, we are to possess an organization which will command respect throughout the scientific world; but in order to guard against such tendencies being carried further than is considered justifiable, and to determine what particular line of research should be pursued in the best interests of the service, or the order of precedence in which particular problems should be attacked, the Controller is empowered to call to his assistance such outside scientists as he may consider desirable to form an advisory council

on which, as a matter of routine, the director of scientific research and representatives of other departments concerned will be invited to sit.

With this object in view, the Royal Society have already been approached and have consented to nominate two suitable fellows who will be willing to attend meetings. Admiral of the Fleet Sir Henry Jackson has also consented to give the council the benefit of his advice.

11. While the above sets forth the organization of scientific research for purely naval uses, it will be the constant endeavor of the Admiralty to work in close collaboration with the army and the air force for the joint prosecution of such researches as can profitable be undertaken in this manner. It may, in this connection, be desirable to state that there already exists the ordnance committee for dealing with ordnance questions affecting the navy and army; the W/T Board affords the necessary liaison between the three services in the matter of wireless telegraphy, and proposals are now under consideration for the creation of a joint (navy, army, and air force) establishment for the investigation of problems relating to chemical warfare.

FUTURE OF BRITISH SHIPBUILDING.—Whether British shipyards will in time be again turning out more tonnage than those of all the rest of the world put together affords an interesting subject for speculation. The latest one to write on this topic is Sir Herbert B. Rowell who, in an article appearing in the London *Spectator*, says that the future of British shipbuilding is inseparably bound up with that of the other countries of the world, and to gauge it requires a study not only of that larger subject, but of the capabilities of his country to recover and improve its position in the field of ship-owning. He says in part:

"Before the war we were paramount as the world's carriers, although menaced by the expansion of Germany. Other countries were also making themselves felt, but to an extent that attracted attention rather than anxiety. With the conditions now existing we must feel that, although the direction from which competition comes has changed, it is none the less real, and that it will take all our skill, experience, and industry to achieve our desired end. That this will be done, and that we shall see the flag of our country holding the place on the oceans of the world that it held formerly, is our hope and belief.

Present Situation Gauged.—"To-day we find ourselves in a position which requires careful weighing and gauging to enable us to arrive at a balanced conclusion, and this applies still more to our position in the future. We may take it for granted that our shipyards have more merchant tonnage under construction than at any previous period; that a considerable demand exists for further deliveries; that building on the whole, notwithstanding the recent falling off in America, is proceeding in foreign countries to an unprecedented extent; and that, on the other hand, we have reason to believe that there is now more tonnage afloat than ever before in the history of the world; also that it will for some time continue to be launched at a greater rate than ever before.

"Against these factors we must take into account that the government controls a considerable amount of tonnage which is being used ineffectively or not at all, and that the tonnage in the hands of shipowners for one cause or another, such as slow working of cargo or bunkers, strikes, want of terminal facilities, and other conditions, is also giving a ton mileage considerably inferior to its pre-war performance. The former of these conditions is certain to change before long, and the latter sooner or later; both, however, are sources from which a virtual increase in effective tonnage will come to supplement new construction, and a study of the future of shipbuilding requires that the potentialities of these two circumstances should be kept vividly before us.

"Against us we have great forces, although of varying character. In China we have efficient and inexpensive labor directed by highly trained

European supervision, with ample deposits of ore which are already being developed, and which promise in the near future to enable steel and other materials to be supplied at reasonable prices. There the works are extending and increasing; the supply of labor is inexhaustible, and regularity and diligence are its outstanding characteristics. In Japan the conditions are similar to those in China, except that the shipyard plants are larger, better equipped, and more modern. The management, which is highly efficient, is in the hands of Japanese who have been trained in the best works and colleges in Britain and America, with the thoroughness which characterizes this race. The greatest disadvantage that Japan labors under is that she is dependent on outside supplies for her steel; but this is being rectified by the acquisition of mineral areas in China and the development of the steel industry, which has already reached a producing stage in Korea.

America's Attitude.—"In America there is a determination and patriotic endeavor to establish herself as a shipowning and shipbuilding country of which we have not seen the end, and the realization of which is assisted by cheap material and efficient if expensive labor. The costs are high, but it is within the power of Americans to say: 'We *will* have, and *can* pay.' The reduction in the United States shipbuilding programme will, in spite of the present labor troubles, have a steady effect on the industry later as the demand for its services diminishes, and even though the result of the present dislocation be an increase in rates of wages, it is improbable that this will be permanent.

"In any case a comparison of the present earnings in America and this country does not give the ratio of their respective costs, as the extent to which mechanical appliances are used there, notably pneumatic tools, gives them a great advantage in volume and cost of work, which is further accentuated by the extraordinary adaptability and effectiveness of their labor. The quality of the ships turned out, especially in the newer yards, has been severely criticised from the view both of workmanship and design. In both respects I consider they are inferior to what is produced in this country, but too much importance has been attached to these features as a permanent handicap to the industry. The designing will improve as soon as it passes into the hands of the private builders and the quality of the work will improve under the fostering influence of Lloyd's surveyors, as it has done in other countries.

"In Germany industry is recovering, and she is working today at prices with which for several reasons—her depreciated currency not being the least—we cannot compete. In some other countries the better labor conditions go far to counterbalance the cost of material and fuel.

"In spite of all, however, I believe that, after the disciplinary period of competition through which the shipbuilding industry of the world is sure to pass, Britain will resume her place amongst the other nations as an economical producer."—*The Nautical Gazette*, June 5, 1920.

JAPAN

JAPANESE SHIPS TO BE PLACED IN RESERVE.—The *Fuso*, *Haruna*, and *Kirishima*, are nearing the "second age" period, and will soon be replaced by new ships.

The present division of ships of the Japanese Navy into ship's age is as follows:

	First period	Second period	Third period
Battleships	6	5	4
Battle cruisers	4	3	
Cruisers	7	4	14
Coast defense ships	1	..	5
Gunboats	..	16	2
Destroyers	45	35	..
Totals	63	63	25

JAPANESE SHIPOWNERS' PROTECTIVE LEAGUE.—According to advices received from the Orient, the Nippon Yusen Kaisha, the Osaka Shosen Kaisha, the Toyo Kisen Kaisha and a number of other large Japanese steamship companies have decided to join the Japan Ship Owners' Association. A powerful league of Japanese shipowners is expected to result from this action, which has been taken with the object of offsetting the inroads made into the Japanese carrying trade by the American and British shipping interests since the war. One of the objects aimed at is a closer co-operation between the Japanese shipping companies so as to eliminate competition between themselves and thus making it possible to meet effectively the competition of foreign shipping.—*The Nautical Gazette*, July 3, 1920.

JAPANESE EXHIBITION SHIP STARTING WORLD TOUR.—Japan has completed arrangements for a floating commercial museum. This is being established aboard one of the larger Japanese liners, which will sail from Yokohama on or about July 15. This education tour will take it into the principal ports of the world.

Stops will be made of from two to seven days, so that prospective buyers may see exhibits of Japanese inventions, fine arts, porcelains, lacquer-ware, raw and finished silk and other Japanese products.—*The Nautical Gazette*, July 3, 1920.

SHIPBUILDING IN JAPAN.—The new Japanese battleship *Mutsu*, which was laid down in 1918 at the Yokosuka Imperial dockyard, was successfully launched on the 31st of last month. This vessel is described as the largest in the Japanese Navy, from which it would appear that her sister ship, the *Nagato*, being built in dry dock at the Kure dockyard since August, 1917, has not yet been floated out. The type they represent is undoubtedly a most formidable one, and to those who are out of touch with current naval progress it may come as a surprise to learn that the *Mutsu* and *Nagato* are more powerfully armed than any ship in the British Navy, and larger than any warship now afloat, with the sole exception of H. M. S. *Hood*. Their chief dimensions are: Length, 661 feet; beam, 95 feet; draft, 30 feet; displacement, 33,800 tons. Geared turbines are to be installed in both ships, from which a speed of 23½ knots is anticipated. The main armament will consist of eight 16-inch guns. The Japanese ships, therefore, are slightly larger and considerably faster than their American contemporaries of the *Maryland* class, the name-ship of which was launched on March 20; but the main armament is the same in calibre and number of guns. Besides the *Nagato* and *Mutsu*, six further capital ships are under construction or about to be laid down in Japan, a number that will bring the establishment up to 17 dreadnoughts or, in popular parlance, "super-dreadnoughts," for all save one of the 17 are armed with guns exceeding 12 inches in caliber.

The exact position of the Japanese naval programme at the present moment is somewhat obscure. According to a government measure introduced late in 1917, a sum of £30,054,800, spread over a period of six years, was to be spent on the construction of two battle-cruisers, three light cruisers, 27 destroyers, and 48 submarines. Of this amount, £2,544,000 were to be disbursed in 1918, £4,771,766 in 1919, £5,412,381 in the current year, £6,819,635 in 1921, £7,122,673 in 1922, and the balance in 1923. Apparently, however, the programme was subsequently modified to include a larger proportion of capital ships. The ultimate aim of the Japanese Government, as explained at the time, is to realize the so-called "eight-eight" system, that is to say, squadrons each consisting of eight battleships and eight battle-cruisers, and to create in time at least three squadrons of this composition. But, irrespective of financial considerations, there are factors which augur none too well for the attainment of this goal within the measurable future. Since the close of the war shipbuilding in Japan has been seriously hampered by the difficulty of obtaining steel. She is dependent primarily on the United States and Great

Britain for her supplies of this material, and within the past two years her imports from both countries have fallen off considerably, owing, on the one hand, to transport difficulties in the States, and, on the other, to the fact that the unfavorable exchange situation makes it more profitable for British manufacturers to dispose of their steel in the European markets. So serious has the shortage become that this year's output of tonnage in Japan is expected to be less than 600,000 tons instead of the 800,000 tons forecast in January. This scarcity of steel is probably reacting on the naval programme, and may account in part for the delay in floating out the *Nagato*. When the war boom in shipbuilding was at its crest new yards sprang up in Japan with mushroom-like rapidity. Just before the armistice no less than 70 shipyards were at work in the Osaka district alone, a number that has lately fallen to 20. The home steel supply was gravely prejudiced at the beginning of the year by an act of sabotage perpetrated at the Yawata works, the only concern in Japan which is capable of producing large quantities of steel. So extensive was the damage that the works had to be closed down for several months. Another factor tending to retard the output of tonnage, naval as well as mercantile, is the higher rate of wages demanded by the shipyard workers. Four years ago the average daily wage of a Japanese shipwright was about a yen (2s.). The present-day average is doubtful, but it is certainly much higher, and fresh claims have lately been put forward on behalf of the workers. Thus the immense advantage which cheap labor gave to Japanese shipbuilders over their rivals in the Occident is gradually disappearing.

So far as technical efficiency is concerned, Japan unquestionably stands in the front rank as a shipbuilding nation. During the period of intensive construction brought about by the depredations of German submarines, many new "records" for quick building were made in the United States, and a yard at Ecorse, Detroit River, claimed to have "licked creation" by delivering the steamship *Crawl Keys*, of 2300 tons gross, 29 days after the keel had been laid. This achievement, creditable as it was, has, however, been surpassed by the Kawasaki dockyard at Kobe in the case of the steamer *Raifuku Maru*, of 5800 tons gross. The keel of that vessel was laid on October 7th, 1918, she was launched on October 30, and her official trials were successfully completed on November 5. In her case, therefore, the building period also covered 29 days, but she was larger than the American vessel by 3500 tons, a difference that makes the record much more noteworthy. In speed of naval construction the Japanese yards are equally well to the fore. The 31,300-ton battleship *Ise*, built by the Kawasaki Company, was completed in 31 months. Twelve 700-ton torpedo-boat destroyers, ordered in Japan by the French Government at the beginning of 1917, were all in service by the following August, some of them having been built so quickly that the average period for the twelve worked out at five months. In the light of these performances the assertion of a leading Japanese yard that, provided the necessary material was forthcoming, they would be prepared to deliver a battleship of the largest dimensions within 20 months from the laying of the keel, a light cruiser within 11 months, and a large destroyer within five months, does not appear to be exaggerated.

The rise and development of modern shipbuilding in Japan furnishes one of the most striking instances of the national adaptability. The squadrons which carried the Japanese flag to victory at the Yalu in 1894 and at Tsushima in 1905 had been constructed almost entirely in foreign shipyards. It was not until 1905 that the first large armored warship was laid down in a Japanese yard. But since that date more than a score of fine battleship and cruisers have been built and completely equipped by the national industry, and at the present moment, as we have seen, battleships of unprecedented size and power are approaching completion in Japan. The growth of the late Imperial German Navy during the 20 years preceding the war was regarded as phenomenal; but considering the great

difference in wealth and productive facilities of Germany and Japan respectively, the latter's achievement in the same sphere of endeavor is even more astonishing.—*The Engineer*, June 18, 1920.

UNITED STATES

MATÉRIEL

OUR NAVAL STANDING.—The fact that we are the only nation which has continued since the war to enlarge its battleship strength made it inevitable that the question of supremacy of the sea would arise and form the subject of discussion—in other words, that our naval policy should stimulate instead of helping to repress that race in naval armaments to which it was hoped that the extinction of the German Navy had put an end. Evidence of this thought and talk is found in an article by Archibald Hurd in a recent issue of the *Illustrated London News*, in which a very striking comparison is made of the strength in capital ships of our own navy and that of the British, when our present programme of construction shall have been completed, that is to say, about the year 1924.

Except for the finishing up of a few of the smaller types of vessels, Great Britain has no construction on hand and has no thought of laying down a new programme. The same is true of France and Italy. In this country, at the time the article was written, we had 18 capital ships authorized or under construction, each of which will be larger and more heavily armed than any existing ships in the world. The battleships include the *California* and *Tennessee*, of 32,300 tons, mounting eight 16-inch and 14 5-inch guns; the four battleships of the *West Virginia* type of 32,600 tons, mounting eight 16-inch and 14 5-inch guns; and, lastly, the six battleships of the *Indiana* class, each of 42,300 tons displacement, mounting 12 16-inch and 16 6-inch guns.

In addition to these are the six battle-cruisers of the *Lexington* class. The designs for these huge ships have been greatly modified, the speed having been reduced, but the size increased. The displacement has risen to 43,500 tons, and they are thus the largest capital ships of any kind on paper or afloat. They will carry eight 16-inch and 14 5-inch guns.

For the purpose of comparison, Archibald Hurd considers that both battleships and battle-cruisers should be divided into two classes, since the first class, or super-dreadnought, to use a rather common but ambiguous term, are so much more powerful than the earlier dreadnoughts or battleships as to require a separate designation. He considers the same thing to be true of the battle-cruisers. So, basing his comparison on the determination of the British to lay down no new ships for a while, he estimates the relative naval strength of the two leading naval powers will stand in 1924 as follows: In first-class battleships, the British have ten carrying the 15-inch gun, and we shall have ten mounting the 16-inch gun; in second-class battleships, the British have 13 mounting the 13.5-inch gun, and our navy will have 11, mounting the 14-inch gun.

In first-class battle-cruisers, the British have three mounting the 15-inch gun, and we shall have six mounting the 16-inch gun. Of second-class battle-cruisers, armed with the 13.5-inch gun, the British have three; we shall have no second-class battle-cruisers. Summing up, we find that by 1924 the British will have 13 first-class capital ships against 16 in the American navy, and that they will have 16 second-class capital ships as against 11 in the United States Navy. As a final consideration, he asks whether, in view of the modifications which are sure to be made, as the records of the war are studied, it would not be better to delay the construction of new ships for two or three years as the British are now doing. The answer to that is that our new battleships and battle-cruisers are supposed to embody the facts of more experience.—*The Scientific American*, June 26, 1920.

"MARYLAND"—OUR FIRST 16-INCH-GUN BATTLESHIP.—The super-dreadnought *Maryland* now completing at Newport News, Va., is the fourth electrically propelled battleship of the United States Navy and sister ship of

NAVY DEPARTMENT—BUREAU OF CONSTRUCTION AND REPAIR

VESSELS UNDER CONSTRUCTION, UNITED STATES NAVY—DEGREE OF COMPLETION, AS REPORTED JUNE 30, 1920

Type, number and name	Contractor	Per cent of completion			
		July 1, 1920		June 1, 1920	
		Total	On ship	Total	On ship
Battleships					
44 California	Mare Island Navy Yard	92.4	90.1	92.4	89.1
45 Colorado	New York S. B. Cpn.	51.1	40.8	49.1	38.3
46 Maryland	Newport News S. B. & D. D. Co.	76.	74.	74.	71.
47 Washington	New York S. B. Cpn.	47.8	35.8	45.6	33.3
48 West Virginia	Newport News S. B. & D. D. Co.	30.5	13.5	29.	11.
49 South Dakota	New York Navy Yard	12.5	5.	11.6	4.1
50 Indiana	New York Navy Yard	10.1	2.6	10.0	2.5
51 Montana	Mare Island Navy Yard	10.9	2.9	9.8	2.2
52 North Carolina	Norfolk Navy Yard	12.5	6.5	10.8	5.4
53 Iowa	Newport News S. B. & D. D. Co.	4.5	2.	3.9	1.
54 Massachusetts	Beth. S. B. Cpn. (Fore River)	....	.....	....	....
Battle Cruisers					
1 Lexington	Beth. S. B. Cpn. (Fore River)	.6	.....	.5	....
2 Constellation	Newport News S. B. & D. D. Co.	.6	.....	.5	....
3 Saratoga	New York S. B. Cpn.	.7	.2	.6	.2
4 Ranger	Newport News S. B. & D. D. Co.	.6	.....	.5	....
5 Constitution	Phila. Navy Yard	1.	.3	.8	.1
6 United States	Phila. Navy Yard	1.	.3	.8	.1
Scout Cruisers					
4	Todd D. D. & Const. Cpn.	54.7	40.5	50.9	35.5
5	Todd D. D. & Const. Cpn.	49.9	30.5	44.9	24.3
6	Todd D. D. & Const. Cpn.	29.7	6.4	29.5	4.3
7	Beth. S. B. Cpn. (Fore River)	6.	2.9	5.5	2.6
8	Beth. S. B. Cpn. (Fore River)	6.	2.9	5.5	2.6
9	Wm. Cramp & Sons Co.	45.	.....	41.	....
10	Wm. Cramp & Sons Co.	43.	.....	37.	....
11	Wm. Cramp & Sons Co.	19.	.....	18.	....
12	Wm. Cramp & Sons Co.	19.	.....	18.	....
13	Wm. Cramp & Sons Co.	19.	.....	18.	....
Miscellaneous					
Fuel Ship No. 17, Neches	Boston Navy Yard	84.	83.	77.	75.8
Fuel Ship No. 18, Pecos	Boston Navy Yard	31.5	20.	29.	16.9
*Gunboat No. 21, Asheville	Charleston Navy Yard	99.8	99.8	99.5	99.5
Gunboat No. 22,	Charleston Navy Yard	48.2	36.2	39.	29.
Hospital Ship No. 1, Relief	Phila. Navy Yard	89.5	87.5	85.	81.5
Amm. Ship No. 1, Pyro	Puget Sound Navy Yard	99.9	99.9	99.6	99.
Amm. Ship No. 2, Nitro	Puget Sound Navy Yard	98.	94.	97.	92.
Rep. Ship No. 1, Medusa	Puget Sound Navy Yard	50.8	38.	46.	35.
Destroyer Tender No. 3, Dobbin	Phila. Navy Yard	24.7	23.	21.7	19.
Dest. Tender No. 4, Whitney	Boston Navy Yard	.....	.....	....	....
Sub. Tender No. 3, Holland	Puget Sound Navy Yard	4.2	.....	2.5	....
Oil Tankers					
1653 Mattole	Wm. Cramp & Sons Co.	98.	.....	96.	.....
1660 Tippecanoe	Newport News S. B. & D. D. Co.	95.	.....	85.	.....
1661 Trinity	Newport News S. B. & D. D. Co.	85.	.....	75.	.....

*Commissioned July 6, 1920.

There are, in addition to the above, 70 destroyers, 51 submarines, and five sea-going tugs in various stages of construction.

There were completed and delivered to the Navy Department during June nine destroyers and one submarine.

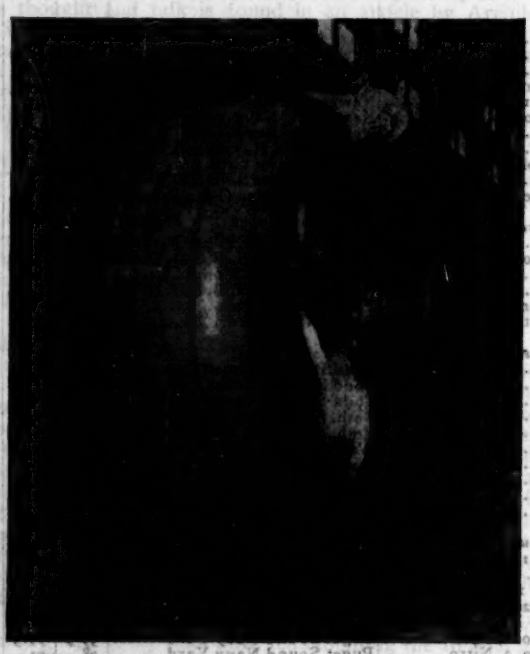
There are 12 destroyers, seven submarines and one transport authorized but not under construction or contract.

the *California*, which is being put into commission at the Mare Island Navy Yard, San Francisco. She is also the first United States ship to mount the new 16-inch gun of which she carries eight in four turrets.

Like her prototype, the *New Mexico*, pioneer electric warship of the world, the *Maryland* is electrical throughout.

Her propulsion equipment was designed and manufactured in the shops of the General Electric Company at Schenectady, N. Y., a city, which because of its pioneer work in electric propulsion has, in a sense, come to be known as the birthplace of electric drive.

Four huge electric motors 12 feet in diameter weighing 62 tons and producing 7000 horsepower each, revolve the great propellers. The current is



ONE OF THE PROPELLER MOTORS.

obtained from two turbo-generator units driven by steam from nine oil-heated boilers placed in three separate compartments of the ship. Approximately 28,000 horsepower is thus available for propulsion purposes or enough to supply power to a city of 100,000 population.

Steam from the boilers under pressure of 250 pounds to the square inch expands into a Curtis turbine and revolves the turbine blades at high speed. This turbine is directly connected to a generator which produces electric current. Through copper cables this current is then led to a control board where it is measured and passed on to the motors which drive the propellers of the vessel.

A portion of the steam produced in the ship's boilers is diverted to six auxiliary turbo-generator sets which create additional energy for the operation of many other electric features of interest.

These auxiliary generating units for instance will supply the vessel's lighting, operate fans and blowers, run the electric bakery, drive the machine tools used in the foundry, carpenter shop and machine shop, operate the electric laundry equipment, assist in loading the big guns, raise and lower the life boats by means of boat cranes and hoist and lower the ship's great anchors.

Electricity will also be used in the refrigerating room which by means of motor-driven pumps, will produce many pounds of ice a day. Electrically-operated pumps will distill gallons of fresh water from the salt waves for the use of the crew and to furnish the boilers with fresh water.

Among other auxiliary uses of electricity on the *Maryland* may be mentioned searchlights, ammunition hoists, electric cooking utensils, telephones and intercommunication systems, gyroscopic compasses, steering gear apparatus (the ship will be steered electrically), motors for revolving gun turrets, air compressors and many other devices making the *Maryland* an electric ship indeed.

The *Maryland* is 624 feet long, weighs 32,600 tons and has a total fuel capacity of about 1,000,000 gallons of oil.

We give below, in chronological order, the various steps in the evolution of the electric drive in the United States:

1907.—First application of the principle adapted to fire-boats in the city of Chicago.

1912.—*U. S. S. Collier Jupiter*, first naval vessel of any nation equipped for electric drive launched at Mare Island Navy Yard, San Francisco, after design of Dr. W. L. Emmet of General Electric Company.

1917 (April).—Emmet's principles applied to *U. S. S. New Mexico*, built and launched at New York Navy Yard.

1919.—*U. S. S. Tennessee*, launched at New York Navy Yard. Navy Department adopts electric drive for six new battle-cruisers to have a speed of 33¼ knots and develop 180,000 horsepower each.

1919 (October).—Fishing trawler of 100 tons equipped with electric drive, the first installation of its kind to vessels of this class.

1919 (November).—Launching of *U. S. S. California* at Mare Island.

1920 (March).—*U. S. S. Maryland*, launched at Newport News, Va.—*The Scientific American*, June 26, 1920.

TWO YEARS OF ELECTRIC PROPULSION ON THE "NEW MEXICO."—As the *New Mexico*, the first United States battleship to be fitted with electric drive, was placed in commission at the New York Navy Yard in May, 1918, she is now just completing her second year of active service. During that time she has seen service of practically every kind that is encountered by a battleship except actual engagement in battle. The results of this service, according to Commander S. M. Robinson, U. S. N., fleet engineer of the Pacific fleet, of which the *New Mexico* is the flagship, have been highly satisfactory and justify the judgment of those who are responsible for the installation of electric machinery in the vessel.

As Commander Robinson gave a very complete description of the *New Mexico's* machinery in this magazine a year ago, it will be remembered that the electric machinery for propulsion consists of two main turbo generators rated at 11,500 kilowatts each at 80 per cent power factor and having an overload capacity of 25 per cent, four main motors rated at 7250 horsepower each and having an overload capacity of 25 per cent, two boosters for varying the current of the main field, two 300-kilowatt exciters for supplying the current to the main field and also certain electrically-driven auxiliaries, together with a main switchboard, an exciter switchboard and the necessary wire and cable. The ship uses one generator for speeds up to 17 knots and two generators for speeds from 17 knots to full speed, which is between 21 and 22 knots. For speeds up to 15 knots the motors are run on the 36-pole connection, so that at 15 knots the turbine

is running at its designed full speed; from 15 knots to full speed the motors are run on the 24-pole connection. This arrangement gives good economy at all speeds, and in order to give our readers a definite idea of just what results have been obtained, Commander Robinson has prepared the following report:

The *New Mexico* has been operating for nearly a year in company with two sister ships, the *Idaho* and *Mississippi*, which have hulls identical with that of the *New Mexico*. During this time it has been possible to get an accurate comparison of the relative economy of the three ships and also the relative maneuvering qualities. In the latter respect, the *New Mexico* is decidedly superior, and the remarkable part of it is that nearly all the maneuvering in restricted waters has been done with one turbo-generator. When this installation was first proposed, its opponents maintained that, while a ship like the *Jupiter* could be satisfactorily operated with the screws on both sides of the ship running at exactly the same speed, it would not be possible to get satisfactory operation with that arrangement on a ship which had to operate in formation. But exactly the reverse has proved to be true; it has been found that more satisfactory operation is obtained when using one generator than when using two, and it is customary, when in dangerous waters where it is desired to take all possible precautions, to use one generator for driving the ship and to keep the other turning over idle. If the ship is getting under way from an anchorage and has to turn, as soon as the anchor is away the signal is given for standard speed ahead on one side and the same speed astern on the other; with this arrangement the ship will turn absolutely on her heel without gaining ground either ahead or astern; with other engines, where it is not possible to regulate the speed so quickly and accurately, the probability of getting speed on the ship in one direction or the other is much greater. All the predictions in regard to trouble on account of the condition that when operating with one generator the screws on both sides of the ship must run at the same speed (if run at all) have proven to be groundless.

In regard to the comparison of economics the results have been very favorable to the *New Mexico*. The *Idaho* and *Mississippi* are fitted with direct-connected turbines (one is Parsons and the other Curtis) and have geared cruising turbines; the *Idaho* can use her cruising turbines at all speeds up to about 17 knots and the *Mississippi* can make about 15 knots with her cruising turbines. Experience gained by a comparison of detroyers fitted with geared main turbines and those fitted with direct-connected main turbines and geared cruising turbines indicates that the economy of the *Idaho* and *Mississippi* at cruising speeds is about as good as it would be if they had geared main turbines. A comparison of the *New Mexico* with these ships is therefore particularly interesting at the lower speeds.

The advocates of electric propulsion have always claimed that it was very superior to all other forms of propulsion at the cruising speeds, but even the most enthusiastic of these have been surprised by the remarkable showing made. This is doubtless due to the fact that no one made sufficient allowance for the saving due to shutting down one generator and all the auxiliaries that go with one of the condensing plants. At a speed of 10 knots the *New Mexico* uses about 16.7 per cent less oil than her sister ships, or, putting it another way, her sister ships use about 20 per cent more than the *New Mexico;* at 13 knots the figures are 29.9 per cent or 42.7 per cent; at 16 knots the figures are 32.3 per cent or 47.8 per cent; at 19 knots the figures are 28.6 per cent or 40.1 per cent; at full power the figures are 24.4 per cent or 32.2 per cent. At 19 knots and also at full power the *New Mexico* uses about .975 pound of oil per shaft horsepower per hour, and at 15 knots she only uses 1.1 pounds of oil per shaft horsepower per hour. This is a remarkably uniform economy.

The *New Mexico* has just completed her annual full-power trials and the following table gives an analysis of the data obtained:

	Full power	Endurance
Revolutions per minute	167.4	151.7
Speed (knots)	21	19.35
Shaft horsepower	28,820	21,650
Pounds of oil per shaft horsepower per hour	.975	.973
Pounds of oil per square foot of heating surface	.506	.3795
Estimated water evaporated in pounds per hour	395,500	294,700
Estimated water per shaft horsepower in pounds per hour (all purposes)	13.65	13.62
Pressure (gage) in pounds per square inch at the boilers	270	265
Pressure (gage) in pounds per square inch at the turbines	255	260
Superheat (in degrees Fahrenheit)	32	23
Vacuum	28.7	29.0

In regard to the reliability of the machinery, the *New Mexico* has had nothing but the most minor troubles with her electric plant and there have been no navy yard repairs whatever; there has been one serious accident to the steam part of the machinery which required work to be done by a navy yard, but that was due entirely to a mechanical defect. Due to improper construction of the main governor, one of the weights became detached while the turbo-generator was running without load; the turbine ran away and operated the emergency governor, which tripped the throttle, but the latter did not entirely close and the turbine ran at over-speed sufficiently to stretch the turbine wheels and the entire rotor had to be replaced. The governor has been changed and additional over-speed protection given by arranging for the emergency governor to close the admission valves as well as the main throttle. The machinery has been in operation nearly a year since repairs were completed and no further trouble has developed.

In conclusion, it may be said that the performance of the *New Mexico* since commissioning has been entirely satisfactory in every way and that the expectations of those who were responsible for its installation have been more than realized.—"International Marine Engineering."—*A. S. N. E.*, May, 1920.

PERSONNEL

THE DISCIPLINE OF THE NAVY.—The continued controversy and bitter feeling arising from the Senate investigation of the navy's conduct of the war has brought about a situation most unfortunate for the best interests of the navy, and one that is utterly subversive of navy discipline. The injection of politics into service affairs has always been, and it is to be feared will continue to be, a serious injury to its best interests. It is the opinion of many conservative officers of the navy that certain very able officers of the navy are being exploited for political purposes, perhaps without their being fully aware of that fact; and that politics and partisanship have no less been injected into navy affairs by certain of those in authority. Whatever may be the justice of the grievance of officers who feel that political or personal motives have been allowed to influence official action, however admirable may be their purpose in desiring to better the efficiency of the service, it is most unfortunate that this should lead to public attacks upon those in authority. Whatever may be the justice of official resentment against criticism, it is doubly unfortunate that this has found expression in appeals to prejudice, in counter attacks that may be regarded as ingenious examples of special pleading, rather than in proper judicial action and unbiased statements of fact. For the present state of undiscipline, to give it its mildest description, the lack of a judicial attitude on one side has led to appeals to the extra-judicial tribunal of public opinion on the other.

The result can only be injury to the service. Discipline and respect for authority are the foundation stones of the navy as well as of the army; a judicial and unbiased attitude on the part of those in authority is no less essential. Partisan or political appeal should have no part in service affairs. Our civic affairs are largely conducted by appeals to public opinion, as a court of last resort, and in a government such as ours wherein all may share this method of open discussion is without doubt an admirable one. But for the services the people as the court of last resort have already set forth in the laws made through their representatives the methods of orderly procedure, the established rule and regulation, that are best conducive to the needs of military discipline. An appeal beyond the law to the court of public opinion that established that law may be made with no other intent than a desire to correct conditions that are an injury to the service. Yet such appeal can but result ultimately in a worse injury to the service than the evils it is desired to correct—may lead to the disruption of discipline, the undermining of the spirit of loyalty to superiors in command. Without discipline, without respect for authority, military or naval organization is ineffective. Authority should deserve respect and should make itself respected; but whether or not it does so, those with the best interests of the navy at heart must recognize the injury to discipline and to the service of appeals against authority that go outside the channels of regulations and of navy law.—*The Army and Navy Journal*, July 3, 1920.

MERCHANT MARINE

JONES BILL SIGNED BY PRESIDENT.—After weeks and months of doubts and heart-searching the Jones Bill, reconstituting the Shipping Board, arranging for the disposition of the Board's tonnage, and vitally affecting the future of the American merchant marine, passed both houses of Congress on June 4, and was signed by the President the following day.

In many respects the Jones measure is a new shipping act, for it gives the Shipping Board powers over shipping not previously possessed. In all probability the Board will in the near future put into operation several policies which have been in abeyance pending passage of the bill. Among these are a new sales programme, a revised agency agreement with managers and operators, a ship repair policy and a general formulation of policy to conform with the sections of the new law.

Secretary of State Bainbridge Colby made a protest against the approval of the bill, based on an examination by the law officers of the State Department, who declared that in several sections the shipping bill violated existing treaties. It was also believed by them that the provisions as to the ex-German ships and their disposition by the Shipping Board would involve the Government in litigation and that the whole matter would be thrown into the courts.

It is recalled that the State Department objected at the time to the preferential tariff provision of the Underwood Bill on the ground that it violated existing treaties. On that occasion President Wilson declared that the portion of the act in question was unconstitutional and therefore of no effect.

Excess Profits Section.—The section dealing with the war profits and excess profits taxes had to be referred back to the conference committee, as the Speaker ruled the section out of order. As passed, the latter provides that owners of American vessels engaged in foreign trade shall for ten years be permitted to deduct from their income tax return the net earnings of their steamers, provided such net earnings are invested in new tonnage in American yards.

However, two-thirds of the cost of such new tonnage shall be paid out of the ordinary capital or funds of the shipowners. The section also provides that in the case of the sale of a vessel, income taxes shall not be payable provided the entire proceeds of the sale be invested in new tonnage in American shipyards.

Under the bill the sale of vessels to aliens can be ordered by the Board only after five of the seven members have agreed that they cannot be disposed of to advantage in the domestic market. The Senate provision limiting the sale to aliens of vessels not exceeding 6000 tons and not less than ten years' old, was stricken out.

The limitation placed on sales to foreigners is outlined in a section providing that "no such sale shall be made unless the Board, after diligent effort, has been unable to sell in accordance with the provisions directing the sale to American citizens and has, upon the affirmative vote of not less than five members, determined to make such sale, and it shall make as a part of its record a full statement of its reasons for making such sale."

Sale of Tonnage.—The sale, to American citizens, may be made on such terms and conditions as the Board may prescribe, with a limit of 15 years for the final payment and at an interest rate on the deferred payments to be fixed by the Board.

The bill provides that 75 per cent of the stock of vessels operating in the trade and the majority of the stock of vessels operating in the foreign trade shall be held by American citizens.

A revolving fund of $25,000,000 to be made up of proceeds of the sale and operation of ships by the Board as created, from which the Board may make loans to any company, corporation or individual, wishing to establish new ship routes, for the building of ships. The revolving fund will operate for five years.

The former German piers at Hoboken are to be turned over to the Shipping Board January 1, next, while other property acquired during the war, except the former German liners already in the hands of the Board, will be turned over at the discretion of the President.

The city of Hoboken is not recompensed for loss in taxation due to the Government acquiring the former German property in that city.

Marine insurance companies may combine, without coming under the jurisdiction of the Sherman or other anti-trust laws, for the "taking of marine insurance risks."

Similar provision is made for the combination of the resources of banking interests for the issuance of ship mortgages.

Coastwise Shipping.—The laws affecting coastwise shipping, which make a monopoly for American ships, may be extended to trade with the Philippines by directions of the President.

The bill provides that the Shipping Board shall be composed of members representing different sections of the country, as follows: Atlantic Coast, two members; Pacific Coast, two members; Gulf States, one member; Lake States, one member, and interior States, one member. The conference committee added the provision that not more than four of the seven members of the Board "may be of one political faith."

The annual salary of members of the Shipping Board is increased from $7500 to $12,000.

Japanese Objection.—From Tokio, Japan, a cable states that, according to the *Hochi Shimbun*, Japan will protest against the Jones Bill, especially in regard to its relation to the shipping of the Philippines. The protest, the Japanese newspaper says, will be made on the ground that the measure is a discriminatory violation of the Japanese-American commercial treaty and represents a blow to Japanese shipping.—*The Nautical Gazette*, June 12, 1920.

AMERICA'S NEW SHIP POLICY.—Has Uncle Sam forfeited the good will of England, France, Norway, Sweden, Holland, and Japan by enacting into law Senator Jones's Merchant Marine Bill? Some of our discerning editors, both on the Atlantic and Pacific seaboards and throughout the central West, shake their heads as they read certain drastic provisions of the Jones Shipping Bill which run counter to obligations assumed by the United States in no less than 24 commercial treaties. Since 1815, they

point out, this country has maintained reciprocal relations affecting shipping with foreign governments, and these agreements were made binding in the form of treaties. Many provisions of the Jones Act, they aver, are discriminatory in favor of American shipowners and against the fleets of other nations.

The New Republic (New York), however, declares that "the Merchant Marine Act is the one notable achievement of the late Congressional session," and the Rochester *Post-Express* agrees. The New York *World* asserts that it is in reality "the most important legislation of its kind ever enacted by Congress." "The big thing," editors agree, "is that a beginning has been made toward restoring the American flag to its proper eminence on the seas." "Only the skilful management, wisdom, and persistence of Senator Jones, of Washington, carried the bill through," agree *The New Republic* and the New York *Journal of Commerce*, and we read in the latter paper that—

"Senator Jones nursed the Shipping Bill through the Senate Committee hearings over a period of two months, framed its provisions in cooperation with the Shipping Board and other members of the committe, prest its passage by the Senate, worked over its sections in conference, and finally led the fight for the measure in Congress. As the man most largely responsible for the act, he speaks authoritatively in interpreting its intentions."

"This is an American act; it is intended solely for American interests," bluntly asserts Senator Jones. Furthermore he goes on:

"European Powers are freeing themselves from treaty provisions that will hinder them in the struggle for the world's trade. We have been prevented from doing what many thought should be done to aid our merchant marine by treaties entered into many years ago. This is a splendid time to unshackle ourselves and put ourselves in a position to make such treaties, to enter into such commercial relations, and to enact such laws as we think will promote our welfare in the world's readjustment. Other nations will look after their interests. We must look after ours.

"British Lloyd's is one of the greatest factors in maintaining a British merchant marine. We should have a similar organization in this country, and we feel that the American Bureau of Shipping should be to our shipping what Lloyd's is to British shipping. We therefore provide in this act for its encouragement by direction all governmental agencies to use that bureau for classification purposes.

"American mail should be carried in American ships, if at all practicable. Of the more than $3,000,000 paid every year for carrying our mail overseas about $2,500,000 is paid to foreign ships. This is so much aid or subsidy to them. This we want stopt. We want our mail carried in our ships."

The question of the right of the Government to dispose of the ex-German liners has been definitely settled by the Jones Act, we are told in *The Annalist* (New York), and there are provisions for the exemption from excess- or war-profits taxes of the net earnings of ships engaged in foreign trade for a period of ten years, with the understanding that the shipping companies must invest, either in government-owned ships or in new construction in American ship-building yards, a sum equivalent to the amount they otherwise would have had to pay in taxes. The act also forbids American railroads to grant export rates on freight to be carried in foreign ships, and it directs the President to repeal or abrogate all commercial treaties which prevent the United States from returning to the system of preferential duties. In order to meet foreign competition, the Government may not only charge lower duties, but it may grant lower port charges and canal tolls. All these concessions are not calculated to arouse great enthusiasm in foreign shipping circles, and there are intimations from abroad that retaliatory measures will soon be in order. Some of them are also criticized in our own country, by the New York *Journal of Commerce*, which says:

"Not the least dangerous element of protection is the grant of low export-rates to goods carried in American bottoms—a measure sure to invite retaliation. Highly objectionable also as a piece of special privilege is the section exempting shipowners from income and excess-profits taxes for ten years to come provided that they annually reinvest in ship construction a sum equal to the taxes they would otherwise have paid to the Government. The legislation is against the spirit of the times, opposed to all sound, economic doctrine, and essentially inequitable. It is more nearly modeled upon the lines of Prussian protectionism as exhibited in Germany before the war. It must, therefore, be a failure in the broadest sense of the term."

The Journal of Commerce of Liverpool is no less outspoken in its criticism of the new Merchant Marine Act. We read:

"It is realized that a United States mercantile marine can not be operated at the same costs as British, Norwegian, Dutch, or Japanese shipping, and it is therefore necessary to extend to shipowning interests in the States the large measure of protection which has always been favored for the development of United States home trade. Whether this policy of coddling will yield the desired results is at least doubtful. Our own shipowning industry has assumed the foremost place without any of the careful nursing which is to be accorded to United States merchant shipping, and the British mercantile marine asks for nothing more than a fair field against all rivals."

"But the common-sense view will be that the United States is solely within its rights in regulating what is, in effect, purely internal commerce," declares the Memphis *Commercial Appeal*, and the New York *Tribune* reminds us that "we built a merchant marine as a matter of military policy, and we expect to keep it both for military and economic reasons. The expansion of the merchant marine is a matter of national concern, to be promoted by all legitimate methods." The Newark *News* looks upon the Jones Act as "a new charter of rights for the American merchant marine," and, adds *The Sun and New York Herald*, "Great Britain can hardly be blamed for watching with something like alarm our 10,000,000-ton merchant fleet." As to our competitors in the shipping business abroad, and the methods which they are said to be contemplating using to maintain their prestige, this paper goes on:

"The hints from London regarding retaliation if we do adopt a preferential policy say that England employed no such discriminatory means to build up her merchant marine, which achieved brilliant and powerful success through a policy of 'no fear and no favor.' Any one who knows the slightest thing about the British merchant marine policy knows this is not a fact.

"England has a perfect right to take these measures if they are necessary to her welfare or if she so desires, her ships; insurance companies, docking facilities, foreign-port concessions, control of trade routs were all obtained by British brains, energy, money, or courage, and England has full freedom to use them as she will for the promotion of her commerce. But to deny to us or to anybody else the same right by saying she practises no shipping discrimination is a plea which must be laughed out of court."—*The Literary Digest*, July 3, 1920.

THE REGISTRATION OF AMERICAN SHIPPING.—It is quite easy to realize the anxiety of those interested in American shipping to make every effort in order to carry on that particular branch of industry apart from any association with the organizations of other nations. It would appear that the Shipping Board of the United States has issued instructions that the managers and operators of vessels belonging to the Shipping Board must obtain their classification from the American Bureau of Shipping. In order

to encourage the development of this practice we understand that the bureau is prepared to make examinations without charge and to issue the necessary certificates resulting from such examinations. The primary object, as far as we can see, is the carrying out of the intentions of the Government to supersede Lloyd's by discontinuing the Lloyd's classification of all American-owned ships. As far as one is able to judge there does not appear to be very much hope that this result is likely to be achieved at any near date in the future, even if it is ever achieved, for the reason that Lloyd's classification has world-wide significance and it will take a long time to break down the desire of shipping owners for Lloyd's classification, mainly for the reasons that underwriters are assured that it is so much better than that of any other organization and a strong feeling prevails that vessels classed under *Lloyd's Register* can always get a better sale. The probability is that political and national influences are dominating the action of the American Shipping Board, but if this is so, the fact must not be overlooked that such considerations do not appeal in any large measure to men of business dealing with problems from a commercial point of view. Although such a policy could be carried out when ships were under the control of the American Shipping Board assuming, however, that those ships passed into the hands of private people, the question of classification and survey will mainly be determined on commercial grounds. We do not see any cause to look upon this action of the American Shipping Board with any anxiety for the reason that all shipping owners of any nationality recognize that the classification of *Lloyd's Register* opens all the markets of the world to the owner desirous of disposing of a vessel from his fleet.—*The Marine Engineer and Naval Architect*, June, 1920.

DECK CREW'S NEW WAGE SCALE.—Below is the new monthly wage scale for American deck crews negotiated between the shipowners, the Shipping Board, and the Eastern and Gulf Sailors' Association. It is to remain in effect until May 1, 1921:

Carpenter	$100.00
Carpenter's mate	95.00
Boatswain	95.00
Boatswain's mate	90.00
Quartermaster	87.50
Able seaman	85.00
Ordinary seaman	65.00
Boy	40.00

—*The Nautical Gazette*, June 5, 1920.

A COMPARISON OF SHIPBUILDING.—The world's shipyards are building a greater volume of sea-going tonnage to-day in the shape of steel steamships than ever in their history, says a statement just issued by *Lloyd's Register of Shipping*, giving returns from all maritime countries. Steel steamers under construction for the quarter ended April 1 are reported to have aggregated 7,692,000 gross tons, as compared with 4,935,000 tons at September 30, 1918, and 7,504,000 tons at September 30, last, the latter being the high record until the quarter just ended.

Total tonnage of all kinds under construction shows a decrease however, the aggregate being 7,941,000 tons, as against 8,048,000 tons on September 30, 1919. This is accounted for by the progress of the Shipping Board's programme towards completion and the marked decline in the building of wooden steamers. Only 105,000 tons of this type of construction are under way, as contrasted with 1,324,000 tons just before the Armistice, since which time there has been a steady falling off. This has been most marked in the United States, where the shrinkage has been from 1,169,000 tons at September 30, 1918, to 55,000 tons to-day.

Figures for the first quarter of this year show that Great Britain now holds the lead in shipbuilding over the United States by a margin of 821,000 tons, although this country led by 1,930,000 tons a year ago. At the beginning of this year the two countries were neck and neck, the advantage being only slightly with the United Kingdom. The following table shows how the two countries have stood relatively at the ends of the various quarters in the total gross tons under construction:

	United States	United Kingdom
Sept. 30, 1918	3,382,000	1,746,000
Dec. 30, 1918	3,645,000	1,979,000
Mar. 31, 1919	4,185,000	2,254,000
June 30, 1919	3,874,000	2,524,000
Sept. 30, 1919	3,470,000	2,816,000
Dec. 31, 1919	2,966,000	2,994,000
Mar. 31, 1920	2,573,000	3,394,000

This includes all types of tonnage. In the construction of steel steamers the margin is a wider one. At September 30, last, the United States still led by 279,000 gross tons; but by the end of the year the United Kingdom had a lead of 334,000 tons and has now extended it to 961,000 tons.

But while Britain is building a greater number of steel steamers and a considerably greater aggregate tonnage than this country, the average size of her ships is considerably smaller, her 814, of 3,379,000 gross tons, averaging only 4,151 tons, as against 5,373 tons for the 450 American ships of 2,418,000 tons.

In the United States more tonnage of all kinds is being built in the shipyards of the Atlantic Coast than in those of the Gulf ports, the Great Lakes and the Pacific Coast combined. In steel steamers the difference is even more marked, nearly 60 per cent of this type of construction being under way along the eastern seaboard. The following table shows the distribution by districts in gross tons:

	All types	Steel steamers
Atlantic Coast	1,602,167	1,585,827
Gulf ports	213,193	180,793
Great Lakes	173,375	173,375
Pacific Coast	584,563	478,163
Total	2,573,298	2,418,158

A year ago the United States was building nearly 54 per cent of all the tonnage underway in the world, as compared to 29 per cent for the United Kingdom and 17 per cent for all other countries. Today this country is constructing 32 per cent, against about 43 per cent for Great Britain and about 25 per cent for all other countries. Excluding Great Britain, however, America is building 80,000 tons more than all the other countries combined.

Between them the United States and the United Kingdom are turning out three-fourths of the world's tonnage and no other country is within measurable distance of either of them. Japan, which has held third place from the time of the Armistice to the beginning of this year, has now been passed by both Holland and Italy and is being pressed by France. All three of the latter made gains during the past quarter, while Japan fell back from 309,000 tons to 285,000.

The distribution of shipbuilding at the beginning of April, as compared with the previous quarter, was as follows, in gross tons:

	Mar. 31, '20	Dec. 31, '19
United States	2,573,298	2,966,515
United Kingdom	3,394,425	2,994,249
Canada	169,623	188,375
Other Dominions	61,636	63,105
Belgium	25,640	26,293
Brazil	5,366	.....
China	35,325	35,700
Denmark	114,851	100,335
France	240,225	216,775
Greece	1,500	1,500
Holland	366,581	328,338
Italy	355,241	314,547
Japan	285,676	309,474
Norway	90,449	92,719
Portugal	5,210	5,210
Spain	98,351	107,463
Sweden	118,553	110,765
Total	7,941,950	7,861,363

Of the total tonnage being built in the world at the beginning of April, excluding vessels the construction of which has not actually been commenced and excluding all vessels of less than 100 tons, the total under inspection by *Lloyd's Register* amounts to 4,965,612 gross tons.—*Shipping*, June 10, 1920.

AERONAUTICS

NAVAL RESERVE FLYING CORPS TRAINING.—Admiral R. E. Coontz, U. S. N., Chief of Naval Operations, has approved a plan of the Bureau of Navigation which will allow qualified aviators of the Naval Reserve Flying Corps to indulge in flying for two weeks during the coming summer. The schedule provided for four stations, which will give 60 aviators practice in heavier-than-air and 20 practice in lighter-than air craft every two weeks. The training is to be given in the discretion of the commanding officers at the stations located at Rockaway Beach, L. I., Hampton Roads, Va., Pensacola, Fla., and San Diego, Calif., so as not to interfere with the regular operations of these stations. The schedule is for the exercise of qualified fliers only, for no provisions can be made for the training of unqualified members of the Naval Reserve Flying Corps at this time. Each of the stations will accommodate 15 in heavier-than-air and five in lighter-than-air craft every two weeks. The training will begin July 1, and the officers who apply for active duty for this training will be assigned as follows: First and Third Naval Districts, to Naval Air Station, Rockaway, L. I. Fourth, Fifth and Sixth Naval Districts, to Hampton Roads, Va. Seventh, Eighth, Ninth, Tenth, Eleventh Districts, to Pensacola, Fla. Twelfth and Thirteenth Districts, to San Diego, Calif.

Commandants of naval districts will arrange all the details concerning the training of the Reserve fliers with the commanding officers of the several naval air stations. Periods of less than two weeks' time actually at the air stations for this training will not be considered. Lack of facilities alone makes it imperative that training of any enrolled enlisted personnel, student fliers or other officers and men in the Naval Reserve Flying Corps be not undertaken during the coming summer.—*Aerial Age Weekly*, June 14, 1920.

A FLYING ACADEMY.—When the American flying service really gets into going order, serious consideration will have to be given to the establish-

ment of an academy similar in type and standing to the military and naval colleges at West Point and Annapolis. Since it is certain that in a few years' time the flying service will be of equal importance if not of more importance than the other services, an air college from which men may be commissioned direct into the service after strenuous tests will become a necessity. The practical interest already taken in aviation by the big educational institutions promises well for the future.—*The Scientific American*, July 10, 1920.

NAVAL RESERVE FLYING CORPS OF 2,000.—The Navy Department has decided that the Naval Reserve Flying Corps (Class 5) will consist of approximately 2,000 officers, all of whom must be qualified naval aviators. In order to obtain and maintain the officers the following plan has been adopted: The required percentage of graduates of designated universities and colleges, who have completed a syllabus of training in aviation approved by the Navy Department, and who meet all other requirements defined by the Navy Department, will be enrolled in the Flying Corps as midshipmen. They will immediately be sent to Pensacola, or other naval air stations, for an intensive course of training for three months or longer. Upon completion of the course graduates will be commissioned either as ensigns in Class 5 or will be discharged, according to whether or not they are considered qualified for all the duties of an officer in the Flying Corps. Every officer in the Flying Corps will be confirmed in appointment after graduation and thereafter will be required to take at least two weeks' active duty for training at a naval air station or with a fleet aviation detachment each year.

Facilities will be open at all times to officers of the Flying Corps at all naval air stations to engage in flights at their own convenience. In order to remain in the Flying Corps each officer must have at least 15 hours' actual time in the air each year of his enrollment. There are approximately 1500 qualified aviators in the Naval Reserve Flying Corps. An officer in the corps will not be re-enrolled after he has had eight years' service; therefore, in order to provide and maintain the necessary number it will be necessary to enroll and train about 400 midshipmen every year. Only officers now in Class 5 who are qualified naval aviators and have had less than eight years' naval service will be eligible for re-enrollment. Enrolled enlisted men will not be eligible for enrollment in this class.—*Aerial Age Weekly*, June 21, 1920.

SOMETHING NEW IN THE WAY OF AIRPLANE METAL RIBS.—Extreme altitudes—the objective of Major R. W. Schroeder and aviators of like ambitions—are not to overshadow another problem of aeronautics, that of of multiplying the speed range of airplanes. A new type of airplane rib developed by the United States Bureau of Standards, by varying the angle of attack, is capable of making greater speed than hitherto possible with the prevailing wings.

Described as the Parker variable-camber wing, the newly-designed equipment recognizes the principle of construction that if the angle of attack can be efficiently varied from a very small to a very large angle, a wide range of speeds is possible. The properties of the type of wing usually seen are held responsible for the restricted speed of airplanes.

Among the features of the rib structure of the Parker variable-camber wing are: Deformation regularly with the load up to the unit flying load, then remains rigid under further applications of weight, being strong enough to stand up under several times its normal load without failure. Simple, foolproof and easily manufactured are the virtues claimed for the wing. Metal construction is necessary in the new type of rib; other portions of the machine such as spars, bracing wires, and struts are not altered. The essential parts of the new wing are: channel-shaped strips forming upper and lower surfaces of the rib between the spars; compres-

sion links are of channel section also and fixed to outer channels by pins, allowing necessary angular motion between links and strips; the tension links are flat strips of steel attached to the same pins which carry the compression links.

A radical departure from the prevailing type of wings, these links in stream-line position carry no load, but in a lifting attitude they straighten out and make a truss of the rib, thus preventing further deformation under loads. The links in the first two and last two panels are slotted to permit of the insertion of reserve links. A tail piece is fixed in shape, riveted to the upper strip and constructed to slide over the rear spar. A spring is placed between the rear spar and the tail piece, this spring being used as a tension attachment to the rear spar and the front compression member of the tail piece.—*The Scientific American*, July 3, 1920.

SUPERCHARGERS FOR AIRPLANE ENGINES.—An airplane flying at high altitude is in an atmosphere of comparatively low density. For instance, at 20,000 feet altitude the density is practically half that at sea level. This means that a given volume contains half as much actual air by weight. The cylinders of an airplane engine are therefore charged with an explosive mixture which has about half the value of a charge at sea level. The engine actually delivers about half of its sea-level power at 20,000 feet.

Both the low temperature and the decreased pressure at high altitude have effect in fixing the high-altitude density. Both the decrease of temperature and the decrease of weight of the charge affect the carburetion at high altitude. The fixed clearance volume and the decreased initial pressure give a decrease of compression pressure resulting in a loss of efficiency. There is, therefore, a combination of causes which gives as a net result a decrease in engine power very nearly proportional to the decrease in density. At high altitude the resistance of the air to the motion of the airplane is decreased directly in proportion to the decrease of density. The power required for a given airplane speed is therefore greatly reduced. However, the engine power has been so reduced that the usual net result is a considerable decrease in airplane speed. When the engine power is maintained at the sea-level value, there is, however, a considerable increase of speed at high altitude.

Filling the cylinders of an internal-combustion engine with a charge greater than that which would normally occur, is called "supercharging." Methods of doing this have engaged the attention of a great many experimenters.

The centrifugal compressor is an apparatus similar to the fan blower except that the shape of the impeller blades and the passages leading air to and from the impeller are so arranged as to give an efficiency very much greater than that of the usual type of fan blower, so that the apparatus forms a satisfactory means for compressing air to appreciable pressures. A line of single-stage centrifugal compressors has been developed for compressing air from 2 to 5 pounds per square inch above atmosphere, to be used for many industrial purposes; as well as a line of multi-stage machines for compressing air and gas up to pressures of 30 pounds per square inch above atmosphere.

The turbo-supercharger is a combination of a gas turbine and a centrifugal compressor, arranged as part of an airplane gasoline engine. The hot products of combustion from the engine exhaust are received upon the turbine runner and furnish power whereby is driven a centrifugal compressor mounted on the same shaft, which compresses air for supply to the carburetors. A more detailed description is given later, as well as particulars regarding its development.

In the latter part of 1917 the National Advisory Committee for Aeronautics requested the co-operation of the General Electric Company in the development of the turbo-supercharger in the United States. Our work was originally started at the suggestion of Dr. W. F. Durand, then chair-

man of the committee, who knew of our long experience with gas turbines and centrifugal compressors. It has since been carried on under the supervision at various times of Col. J. G. Vincent, Col. T. H. Bane, Major H. C Marmon, Major G E. A. Hallett and Major R. W. Schroeder. Major Hallett has had charge of the development since the armistice, and he has given considerable study to the matter of superchargers in general.

The Turbo-Supercharger Cycle.—Fig. 1 shows an airplane engine equipped with a turbo-supercharger. The exhaust of the engine is received by an exhaust manifold which leads it to a nozzle chamber carrying nozzles which discharge it on to the buckets of a turbine wheel. On the same shaft as this turbine wheel is the impeller of a centrifugal compressor. This compresses air from the low-pressure atmosphere to approximately normal sea-level pressure and delivers it to an air-discharge conduit which supplies the carburetors.

The turbine nozzles are of such area as to maintain within the exhaust manifold and nozzle box a pressure approximately equal to that at sea level. The difference between this pressure and the altitude low pressure gives a

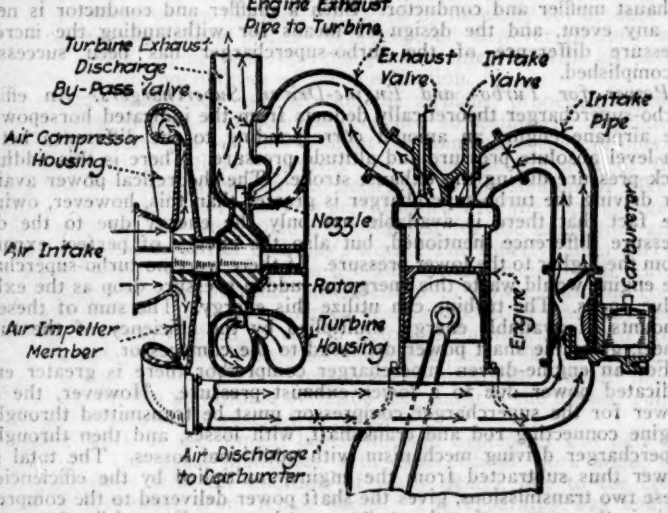


FIG. 1.—Diagrammatic Sketch of an Airplane Engine Equipped with a Supercharger.

pressure drop for the exhaust gases which furnishes the power that operates the system.

Due to the respective temperatures this power input suffices to give the desired compression and also to supply the inevitable losses. However, in order to avoid back pressure on the engine, above the normal sea-level value, both turbine and compressor must be designed with utmost attention to efficiency.

With an efficient arrangement the engine when at high altitude exhausts at normal sea-level pressure and receives its air at the carburetor at normal sea-level pressure. Hence, normal sea-level power is delivered at all altitudes up to the maximum for which the supercharger is designed, so that the plane speed will increase uniformly as the altitude density decreases.

Mechanical Problems of Supercharging.—The General Electric superchargers thus far constructed have been designed to give sea-level absolute pressure at an altitude of 18,000 feet, which requires a compressor

that doubles the absolute pressure of the air. This pressure ratio, with the quantity of air involved, means about 50 shaft horsepower input for the compressor. The design of a complete power plant of this size to suit an existing airplane engine, with such weight and location as will not impair the flying characteristics of the plane, has of course offered many problems. The possibility of driving the compressor of the supercharger by engine power instead of by the exhaust gases suggested itself. Much experience with the operation of the gas turbine, however, led the writer to prefer its problems to those of the driving mechanism of a supercharger operated from the engine. The turbine involves merely the addition to the compressor of a single extra wheel, designed for the conditions, with no extra bearings. The engine-driven scheme involves a 50-horsepower transmission with a multiplicity of gears, bearings, clutches, belts, and the like. These offer more or less drag on the engine when the supercharger is not in use at low altitudes, and very serious problems of acceleration when the supercharger is to be thrown into action, since the engine will be then running at its full speed of about 1800 r. p. m.

The exhaust manifold and nozzle box have proved to be a very efficient exhaust muffler and conductor. Such a muffler and conductor is needed in any event, and the design of means for withstanding the increased pressure difference of the turbo-supercharger has been successfully accomplished.

Power for Turbo- and Engine-Driven Superchargers.—An efficient turbo-supercharger theoretically deducts from the indicated horsepower of the airplane engine an amount corresponding to the difference between sea-level absolute pressure and altitude pressure. There is this additional back pressure during the exhaust stroke. The theoretical power available for driving the turbo-supercharger is greater than this, however, owing to the fact that there is available not only the energy due to the direct pressure difference mentioned, but also the energy of perfect expansion from the higher to the lower pressure. If there were no turbo-supercharger the engine would waste this energy in sudden pressure drop as the exhaust valve opens. The turbine can utilize this energy. The sum of these two amounts of available energy, multiplied by the efficiency of the turbine wheel, gives the shaft power delivered to the compressor.

For an engine-driven supercharger compressor there is greater engine indicated power due to a lower exhaust pressure. However, the shaft power for the supercharger compressor must be transmitted through the engine connecting rod and crankshaft, with losses, and then through the supercharger driving mechanism with additional losses. The total shaft power thus subtracted from the engine, multiplied by the efficiencies of these two transmissions, gives the shaft power delivered to the compressor. This is the same as for the turbo-supercharger. For a Liberty motor of about 400 horsepower and sea-level power at 18,000 feet altitude, this power is 50 horsepower.

The comparison then is as follows: The turbo-supercharger substracts from the engine indicated power, adds power of expansion which would not otherwise be used, and has turbine wheel losses. The engine-driven supercharger puts this indicated power through the engine (with some additional loads on the pins and bearings) and has engine and transmission losses.

With usual efficiency there is probably not a great difference between the gross substraction from engine power in the two cases. There is then the disadvantage of transmitting the supercharger power through the engine pins and bearings, as well as through some mechanism between engine and supercharger, to be compared with the collection of the hot gases under pressure (with muffling advantages) and delivery to the turbine wheel. As already mentioned, practical success to date is in favor of the turbo-supercharger and the writer feels that this is really due to its innate superiority.

Engine-driven superchargers with positive-pressure blowers have been proposed. These have the additional disadvantage that with the desirable pressure ratios of about two to one there is an appreciable compression loss due to the fact that the machine only displaces air and has no direct means for compression.

Supercharging engines of various kinds, in which the engine crankcase or the engine cylinders themselves are arranged for additional compression, have been shown to give excessive weight and complication as compared with a turbo-supercharger.

Development of the Turbo-Supercharger.—The machines used thus far have been designed to give sea-level pressure at 18,000 feet altitude, which corresponds to a pressure ratio of about two. The rated speed for these conditions is 20,000 r. p. m. Sea-level pressure has readily been obtained up to 22,000 feet altitude. The control is entirely by hand operation of waste gates, which permits of free escape of some of the exhaust gases.

The entire apparatus, exclusive of exhaust manifold and air-discharge conduit, weights about 100 pounds. The exhaust manifold and air conduits have nearly the same weight as equivalent parts with no supercharger.

The turbine and compressor wheel have diameters somewhat less than a foot. The present design has been hampered by necessity for accommodation to existing engines and planes. It is proposed, however, to construct apparatus in which engine and supercharger are integral, with all parts arranged for the full possibilities of the combination.

In the combination under consideration the airplane, propeller, engine, radiator, cooling system, and supercharger are so intimately associated that no adequate tests can be made without the complete system in operation at full speed at altitude. During the initial development of the Liberty motor a testing expedition had been sent to the summit of Pike's Peak, and it was decided to repeat this performance with the supercharger. Fig. 2 shows the motor truck that was prepared for the expedition and Fig. 3 the way it was left after each day's work. The Liberty motor carrying the supercharger was mounted on a cradle dynamometer, with scales and all arrangements for accurate measurement of power, gasoline consumption and the like. In fact, a complete testing laboratory was provided. The motor truck was shipped by rail to Colorado Springs, and then proceeded by its own power to Pike's Peak summit on the "Pike's Peak Auto Highway," a well-constructed but very tortuous mountain road 28 miles long. The summit has an altitude of 14,109 feet and it is the highest point in the United States easily reached by road.

The testing work at the summit lasted through September and half of October, 1918. The usual difficulties with experimental work were, of course, encountered with the addition of many delays, due to the cold and snow, and distance from repair shops. The apparatus was finally arranged to give good mechanical operation and it was found possible at the existing altitude of 14,000 feet not only to supercharge so as to give full sea-level power, but also to overcharge so as to cause the engine to preignite.

It was agreed that results of the tests warranted the immediate installation of the supercharger on an airplane, and arrangements for doing this were in progress when the armistice caused a cessation of the work. After the armistice, careful reëxamination of the situation resulted in resumption of the work in the early part of 1919. Various rearrangements were made in view of the experience gained at Pike's Peak and the apparatus was finally installed on an airplane.

It soon developed that a very appreciable increase of power was easily obtained when the supercharger was opened up. The whole airplane installation was not properly arranged to take advantage of this power, however, and changes were necessary in the radiator, cooling system, propeller system, gasoline tank, pump system, etc. Changes in these parts have been made from time to time, and this work is still in progress. As the work

proceeds more and more power is developed by the engine. Changes have also been made in the supercharger itself.

Fig. 4 shows Major R. W. Schroeder, who has made all of the flight tests to date, together with Lieut. George W. Elsey, who has made all of the flight observations to date. The aviators are of course clothed for the intense cold of high altitudes and carry the parachutes that are now regularly used by the U. S. air service in experimental work.

Supercharger Performances.—The supercharger which has been used to date was primarily desired for high speeds at altitudes of 18,000 to 22,000 feet. The Le Pere plane on which the installation was made had a ceiling of about 20,000 feet with two men, and a speed at this altitude of 70 miles per hour. With the supercharger in use, a speed of about 140 miles an hour has been attained at 22,000 feet. As already pointed out, this has been attained with various parts of the plane installation in a partially developed state. Theoretical computations have been made showing that much higher speeds at high altitudes are to be expected, and the flight tests to date indicate that the theoretical expectations will be fully realized.

The making of high altitude records has been very attractive and the supercharger has, of course, been used for this purpose as well as for the speed courses mentioned. Successively higher altitudes have been reached as experience has been gained regarding the manipulation of oxygen, gasoline, and other details.

On February 27, Major Schroeder made a flight alone, attaining an actual height above the ground finally computed as 36,130 feet (6.85 miles). The lowest temperature reached was minus 67 degrees Fahrenheit. At the maximum altitude his oxygen apparatus failed and he became unconscious and lost control of the plane, which fell almost vertically. As he neared the earth he partly recovered consciousness and, at an altitude of about 3000 feet, succeeded, in a half-dazed semi-automatic way, in righting the plane and making a good landing in his own field, again becoming unconscious. He was taken to a hospital in a serious condition, but has since almost completely recovered. The supercharger, engine, and plane were in perfect working order after the flight.

At the maximum altitude attained, recording instruments showed that the plane was still climbing at the rate of about 125 feet per minute and it was estimated that an altitude of 40,000 feet would have been attained if the oxygen apparatus had not failed.

[In the May issue of the *General Electric Review* there also appears a reprint of a paper on Superchargers and Supercharging Engines, by Major George E. A. Hallett, U. S. A., presented at the annual meeting of the Society of Automotive Engineers, January 7 and 8, 1920. Major Hallett, who is chief of power plant division, U. S. air service, deals at some length with the various methods employed in supercharging and refers to the work of the U. S. air service on the Rateau type of turbo-compressor, under the supervision of Mr. E. H. Sherbondy, prior to that undertaken by Dr. Moss. Commenting on the working of the Moss supercharger, he says:

"It would naturally seem at first thought that the extremely low temperatures always found at great altitudes would make possible the easy solution of cooling problems, but in reality the low density of the air reduces its heat conductivity and capacity for heat absorption to such a point that a supercharged engine developing sea-level power at 20,000 feet requires a little *more cooling surface* than it does when developing normal power at sea level.

"The Liberty engine and many others run best with a water temperature of about 170 degrees Fahrenheit. To maintain the cooling water at this temperature in the reduced atmospheric pressure at 25,000 feet it is necessary to use several pounds of air pressure in the radiator to prevent the water from boiling away. Very effective radiator shutters are needed when the engine is throttled to make a descent from altitudes of over

20,000 feet to prevent the water in the radiator from freezing before warmer air is reached.

"Contrary to expectations, the Moss turbo-compressor now being tested at McCook Field does not complicate the pilot's controls. On a normal engine the pilot handles the throttle and the altitude carburetor control which thins down the mixture as he ascends. With the turbo-compressor the altitude control becomes unnecessary up to the altitude at which the engine can no longer deliver sea-level power but is used, as with a normal engine, if the plane is driven higher."

As to the future of the supercharger, Major Hallett says:

"The uses of the supercharger for military service can be divided into: first, for airplanes in which it is desired to reach extreme altitude; second, for airplanes in which it is desired to increase the rate of climb and horizontal speed and therefore maneuverability at altitudes where it is intended to fight; and, third, for airplanes which carry large loads such as bombers, which normally are handicapped by having a very low ceiling and whose entire usefulness would, if larger engines were installed to pull them to a higher ceiling, be lost on account of the large amount of fuel and other material that would have to be carried, thus decreasing their radii of action.

"In the first case it is believed that a special supercharger can be built that will make feasible much greater altitudes than any that have been attained with the present General Electric turbo-compressor; and it is considered essential that we have airplanes, capable of reaching very great heights. In the second case, it is pointed out that military machines not fitted with supercharging engines, when fighting at an altitude of 20,000 feet or more, are so near their ceiling that their rate of climb, speed, and maneuverability are comparatively poor, but the use of a supercharger seems to overcome this difficulty easily.

"The use of superchargers in commercial airplanes of the future is assured because superchargers will make possible far *more miles per hour* and *more miles per gallon* with a given engine and airplane, and speed is the main advantage of air over other kinds of transportation. It is thought by many qualified judges that by flying at a sufficient height with a supercharged engine and a suitably designed airplane, a speed of 200 m. p. h. can be maintained."]—*The Journal Am. Soc. M. E.*, July, 1920.

HELIUM GAS.—The development of a non-combustible gas, of good lifting power, for all balloon purposes, is such as desirable thing, that it is not surprising that the war led to a strenuous effort to separate large quantities of helium from the enormous gas supply in certain fields. Helium has a molecular weight of four against two for hydrogen, hence its lifting power is about 92.6 per cent that of hydrogen. Helium is monatomic.

The Petrolia, Texas, field alone has in the past delivered as much as 30,000,000 cubic feet of natural gas per day carrying as high as 300,000 cubic feet of helium to waste in the furnaces and stoves of the cities of Dallas and Fort Worth. Even greater quantities of gas exist in Ohio, but the helium content is much less.

It appears that natural gas carrying ⅓ to ⅔ per cent helium is available in immense quantities, and it only remains to separate the helium cheaply to make ballooning perfectly safe, particularly against accident from fire.

However, it is no small problem to liquify a gas which may consist of 30 per cent nitrogen, 50 per cent methane and 19 per cent ethane, propane, butane, etc. Fortunately, the remaining one per cent of helium need not be liquefied, since its boiling point is 4¼° C. abs. The nitrogen and methane liquefy at minus 195.66° and 161.7° C. respectively, and these temperatures are not difficult to reach.

Three plants were installed during the war. Two of these were located at Fort Worth, Texas, and both produced some helium at a very high cost, say, from $200 to $300 per thousand cubic feet.

The third plant was located at Petrolia, Texas, immediately at the gas wells, and unfortunately depends on the operation of a privately-owned and operated gas compression and gasoline extraction plant.

The interference of the residual gases, ethane, propane, etc., from the gasoline extraction system, has prevented even a study of the operation of this plant under proper conditions.

It is evident that if the condensing system becomes cold enough to condense nitrogen, for instance, the sudden admission of even methane would at once put the condensing system out of commission, while a gust of ethane would be even worse.

Under the most adverse conditions, as to variable gas supply, the plant has been operated for about one year. Helium up to 20 per cent has been recovered in small quantities, and it only remains to remove the external difficulties and to provide reasonable control over the gas supply to make an increased output and higher purity a matter of natural sequence.

The system used at Petrolia differs from the other plants in that the gas is liquified and distilled at a pressure of 300 pounds per square inch.

Very powerful expansion engines, three in number, expand the gas after separation, and their very cold exhaust serves to refrigerate the interchanger system. These interchangers resemble counter current condensers, and have about 14,000 tubes, and a surface of 8,000 square feet is available to cool and condense the gas.

The stills are essentially of standard type, except that they are maintained at high pressure. As high a ratio as 80 has been reached in the relative helium content of gas treated and the discharge of still.

The economical production of helium depends altogether on the seemingly independent matter of freeing the gas from gasoline vapors.—*The Tech. Engineering News*, June, 1920.

ENGINEERING

WELDS AND WELDING.—There can be no doubt about the attractiveness of "welding" as a means of making joints in metal structures. Its advantages are so obvious and appear to be so great. First and foremost is the advantage of cheapness and convenience; electric and acetylene welding can be carried out not only with much less labor, but with much greater speed and convenience than the older methods of making joints. By comparison, riveting—involving, as it does, the drilling or punching of holes in accurately determined positions, followed by the insertion of the rivets themselves—is a clumsy and a costly operation. From the point of view of the strength of the resulting joint also, riveting is far from satisfactory; only by great care in design and construction can a strength approaching as much as 70 per cent of that of the original bar be obtained, and in most joints the strength is very much less. Further, there are many cases where broken parts can be re-joined by "welding" while riveting is out of the question and other methods are impracticable. It is small wonder, then, that this method of jointing structures by autogenous fusion is finding ever wider and wider application. Its rapid rise into widespread popularity has, further, been very materially assisted by the conditions prevailing during the war, when very rapid repair work, particularly, was rendered possible by the use of arc or blow-pipe, where older methods would have failed us.

When a new method of this kind achieves such widespread and growing application it can no longer be a question of discussing whether it is or is not useful. On the other hand, the question does remain to be considered—and it needs very careful consideration indeed—whether the application of welding methods may not be pushed too far, whether the cheapness and convenience of the method may not lead to its use where such use is undesirable or even seriously dangerous. To discuss the matter from this point of view, and even to insist upon certain important limitations to the

use of welding, is by no means a sign of hostility to the progress of what is really a new industry. On the contrary, the most ardent advocates of welding, and those most directly interested in its development from the business point of view, must admit that it could only do the process serious harm if its use were to be extended to cases where serious harm might result. The occurrence of a few failures, even if by good fortune they should not be disastrous if traceable to the injudicious use of welding, would do more to hinder the useful and sound development of the welding industry than a hundred really successful applications could do to stimulate it. For that reason we would ask those who advocate the application of welding to all manner of engineering structures, and those whose safety depends upon the soundness of those structures, to consider very carefully where and how welding can be safely and judiciously employed. Failing such judicious restraint, a reaction is likely to occur, leading possibly to the imposition of stringent restrictions if it should be found that public safety may be jeopardized. In considering what limitations, if any, should be placed upon the use of autogenous welding it is necessary to consider the character of the weld itself. In the case of a "perfect" weld—that is, a weld free from any unsoundness—there is no doubt that we have a joint in many ways stronger than and superior to a riveted joint, and one possessing at the same time the considerable advantage of being water and steam-tight. But although stronger than a riveted joint, such a joint does not attain the strength of the unaltered material. In the first place, the weld proper consists of steel or iron which has merely cooled down from a state of fusion without undergoing subsequent refining either by work or heat-treatment. Even though such material behaves well under an ordinary tensile test, there can be no doubt that it is much less reliable and satisfactory than properly worked and heat-treated steel. Tests show, however, that this material which has been actually molten is not the weakest part of a sound weld; the weakest area is generally found a short distance on either side of the weld proper, where the adjacent steel has been exposed to that temperature which leaves it in the weakest and softest condition. It is, of course, true that even in this softened, weakened condition, the steel may be amply strong enough to bear the stresses coming upon it; but this weakening, and particularly the lowering of the elastic limit, requires careful consideration by the designer who intends to rely on welded joints in his structures.

The most serious difficulty in the use of welded joints where the main stresses of a structure have to be borne arises from the fact that it is not only difficult to produce sound joints, but that it is practically impossible to tell by examination whether a given weld is or is not really sound. Cases of failure having more or less serious consequences are of increasingly frequent occurrence at the present time, where the trouble is directly traceable to a defective weld. In some of these cases careful inspection would at once have thrown serious doubt on the adequacy of the weld, but in other cases the defects are entirely covered and can only be seen when a section is cut through the weld or its two parts are torn asunder in servcie. Careful workmanship and rigid inspection can no doubt serve to reduce risks of this kind, but it is at least open to very serious question whether a process which is undoubtedly liable to this danger should be employed for making joints of primary importance exposed to heavy working stresses. Even during the war the risks involved in the use of welded joints in aeroplane construction were fully recognized, and the use of the process for that purpose strictly limited. But even where, in the repair of boilers and bridges and in the construction of ships it was rightly regarded as a legitimate war risk to employ electric or acetylene welding even for vital parts exposed to main stresses, it is another matter to adopt the process broadcast for the regular uses of peace time. The improvement in the methods of welding and in the knowledge of the materials welded and the increase in the skill and experience of welders may in time put the

process beyond all doubt. But we have not reached that stage yet, and until we do, it is advisable to move slowly and not to be deflected from a cautious path by the remarkable successes already attained.—*Engineering*, June 25, 1920.

OBTURATORS IN INTERNAL-COMBUSTION ENGINES.—*Obturators versus Piston Rings.*—Experiences in air-cooled engines on aircraft led in some cases to the replacement of the ordinary piston rings by an obturator, which is essentially the equivalent in metal of the cup leather used for packing hydraulic cylinders. The air-cooled cylinders of rotary engines, it was found, suffered distortion when at work owing to the leading side of the cylinder being more effectually cooled than the trailing side. As a consequence, piston rings often failed to hold the pressure satisfactorily. Any increase in their number would have involved a longer and heavier piston, and the obturator was introduced in consequence. This, as explained in an interesting and valuable paper by Mr. W. Fennel, M. I. E. E., which was read at a recent meeting of the Diesel Engine Users' Association, consisted of a flexible L-shaped ring forced against the cylinder wall by fluid pressure. At the outset the life was short, but improvements made at the works of "Engineering and Arc Lamps" increased the life from 10 hours to 60 hours, and in exceptional cases to 250 hours. Brass was the metal first employed, but a special phosphor bronze is now used. The obturator was placed near the top of the piston, but being flexible and forced by the pressure into close contact with the relatively cool wall of the liner, it did not burn. Nevertheless, it is now considered preferable to fix it some little distance below the piston head. As originally fitted the rings were split similarly to a piston ring, but a lap joint is now used and with this the obturator works well, even if the liner be worn out of true. In consequence of the satisfactory behavior of these obturators, Mr. Fennell determined to fit one to a three-cylinder Sulzer-Diesel engine rated at 140 horsepower. The liners of this engine had worn badly, being far from circular and tapering to the extent of 0.1 inch. It was impossible under the conditions to obtain new liners, and piston rings failed so rapidly the engine could not be run save at a prohibitive cost. It was decided accordingly to fix the three top rings of the piston and to place an obturator in the fourth groove. After a run of 100 hours without loss or blowing by, the obturator was examined. The wear was less than one mil, and the engine was set to work again, without replacing it. This obturator lasted 380 hours and then failed, due to wear at the lap joint. Here the motion was considerable, owing to the taper of the liner. Further experiments showed that even with these badly-worn liners the obturator might be counted on to last 300 hours, which was longer than the piston rings would stand. Further tests, Mr. Fennell stated, are in progress, and they indicate that with the liners in proper condition the life of the obturator should be well over 1000 hours. *Engineering*, April 16, 1920.—*The Journal Am. Soc. M. E.*, July, 1920.

INCREASE IN MOTOR SHIPS.—It may be a matter of general interest to know that there are at the present time no fewer than 150 motor ships being built, representing in cargo capacity over one million tons. Statistics regarding the number in use give an adequate idea of the extent to which the motor ship is supplanting old and familiar types. There is no need at this stage to discuss the advantages claimed for the motor-driven vessel in comparison with the steamship. These are known; the disadvantages are also recognized. It would be futile, of course, to expect the same reliability of operation in the case of the marine internal combustion engine in the sizes required for ocean-going ships to that which is associated with steam propelled vessels. In spite of the considerable advances which have been made, there are still problems which have to be solved before the majority of shipowners will be persuaded to turn their backs upon the steam engine and adopt the internal combustion engine for purposes of ship

propulsion. The argument which is sometimes used, that the space required for fuel storage in the case of the marine motor is very much less than that required for the storage of coal, scarcely applies to-day, when so many vessels are being fitted to use oil instead of solid fuel under boilers. Those who are interested in the progress of the motor ship need not, however, entertain any fears that the subject is not rated at its full importance by our shipbuilders and marine engineers. Some of the leading shipbuilding and engineering firms are not merely "standing-by," awaiting for a new development, but are allocating considerable sums to the investigation of the features which underlie successful design. Work on the evolution of the best type of motor for purposes of ship propulsion is in hand, and, as one or two recent installations have indicated, some notable results have been achieved. In spite of the lead gained by German manufacturers in the field in the pre-war period, we need not imagine that we are going to do anything in the future but show the way in developments in this field.—*Shipping*, May 25, 1920.

THE SOLID INJECTION OIL ENGINE.—The air compressor, be it a direct-connected or a separate unit, furnishes a large percentage of the Diesel-engine troubles. The pressures and conditions under which it operates are such that lubrication is difficult; valves often leak and packing troubles are always present. Furthermore, since considerable quantities of air are employed in the injection of the fuel charge, the power demands of the compressor range from 6 to 10 per cent of the horsepower developed in the engine. Many Diesel designers have attempted to eliminate the compressor, but with little success. Where the engine on the Diesel cycle, the injection of oil occurs a considerable period of the power stroke, and it is necessary to have some means whereby the pressure in the fuel-oil lines can be kept constant during the period of injection.

The Vickers Co., of England, several years ago abandoned the air blast on their Diesels and now make use of a fuel-injection system having a flattened steel tube to maintain the oil pressure. This design apparently is very successful since many Vickers Diesels are in daily service in the British navy and in the merchant marine.

The explosive, or constant-volume, oil engine does not require a constant oil-line pressure nor the somewhat complicated fuel-valve mechanism of the Diesel, and it is to this type of engine that the solid injection principle is most adaptable. The one feature with the solid injection engine that requires the most careful designing is the atomizer, or injection nozzle. Since there is no air blast to break up the fuel, the atomizer must do this mechanically. In fact, the oil must be atomized in a more perfect manner than necessary with the air-injection engine. Furthermore, the nozzle must handle the oil without the dribbling effect so prevalent in hotbulb designs.

In the Diesel engine it has been customary to employ a compression pressure ranging from 450 to 600 pounds per square inch. Those engineers accustomed to these pressures are under the impression that with the lower pressures encountered in the explosive engine the temperature will be entirely too low to cause auto-ignition. It then appears unreasonable to operate an engine having a compression pressure of 200 to 300 pounds without a hotbulb or other ignition device. The following explanation is given with the idea of clearing up this question.

It has been proved that a fuel will ignite at a temperature well below 800° F. provided it is atomized or broken up to allow each minute oil particle to be in contact with the necessary amount of air. It is apparent that two things are required—thorough atomization and proper temperature. Fig. 1 is a curve showing the relation of temperature and pressure where the compression is adiabatic. This curve is based on the equation,

$$\frac{T_1}{T_2} = \left(\frac{P_1}{P_2}\right)^{1-\frac{1}{n}}$$

T_1, the temperature at the beginning of compression, is here assumed to be 212° F. When the engine is warmed up, this value is about correct, although on starting cold, T_1 will be somewhat lower. The exponent n is assumed to be 1.35 instead of 1.41, with the intention of making allowance for the loss to the cylinder walls during compression.

The temperature with 300 pounds final compression pressure is approximately 1050° F. This is amply high to ignite any of the fuel oils. The Diesel engine, with its large radiating surface relative to its compression volume, experiences a loss of temperature that is much greater than in the

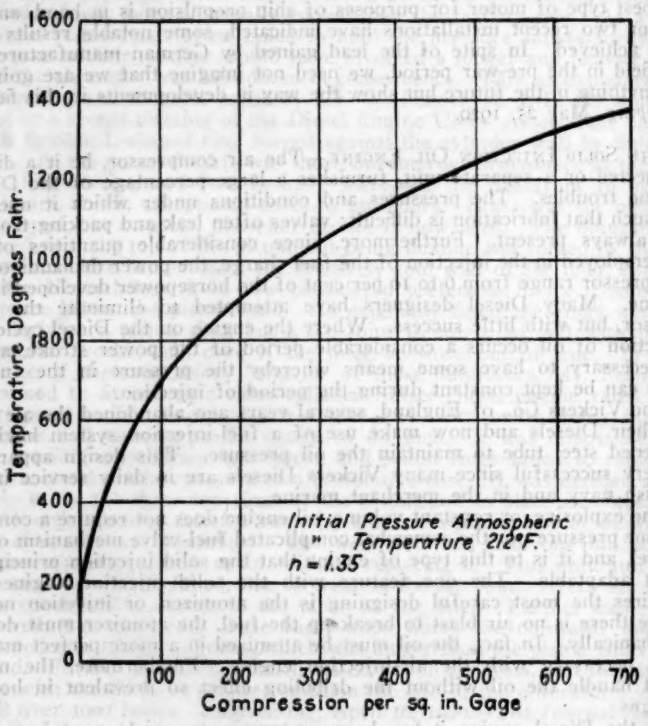


FIG. 1.—Curve Showing Relation of Temperature and Pressure Where Compression is Adiabatic.

case of the solid-injection engine having a combustion chamber with a large volume and a small radiating surface. It is quite likely that the chilling effect of the expanding air blast in the Diesel causes a drop of at least 150° F. in the temperature of the air and oil. As a practical example of the ability to operate at 300 pounds, many operators are running old Diesels with a still lower compression.

As has been stated, the curve in Fig. 1 is based on an initial air temperature of 212° F. On starting a cold engine, this value is much too high; if there is no throttling of the air, it should be around 70° F. This would give a final temperature of about 725° F., which is sufficient to ignite a well-atomized fuel charge, although the first few explosions will probably smoke badly. To secure thorough atomization and ignition, it is necessary

that the oil be broken up without any part striking the relatively cold walls of the combustion chamber. This has led to various designs of combustion chambers as well as atomizing devices.

In this discussion no consideration has been given to the effect the injected oil has on increasing the pressure and temperature of the mixture in the combustion chamber or to the time element as applied to the period of vaporization of the oil. There is no doubt that both these factors have marked influences on the action of the engine.

The timing of the injection of the fuel varies in different makes of engines from 40° to 6° ahead of outer dead center. The operator of a Diesel knows from experience that an injection point much over 7° ahead of dead center will produce marked preignition; in the hot-bulb engine an injection point of 30° will cause severe pounding unless water injection is employed. In the solid-injection oil engine it has been found that the timing is largely dependent on the compression carried. If the compression is as low as 200 pounds as in the Price engine, the injection must be earlier than 30° to give ample time for the vaporization of the oil, while with 300 pounds pressure, as with the De La Vergne S. I. engine, the injection is not over 6°. To avoid danger of preignition at early injection periods, a combustion chamber is placed in the head. The oil is injected into this space where it mixes with the air. Since the major part of the air charge is contained within the cylinder, the amount of air in the combustion chamber is not sufficient to produce ignition even with a sufficiently high temperature. Ignition can occur only when the moving piston forces the main air charge into the combustion space.

The fuel consumption per brake horsepower is low; in many cases it equals the best Diesel results. Since the compression is much lower than with the Diesel engine, the thermal efficiency based on indicated horsepower is not as good as with the latter engine. The extremely high mechanical efficiency, due to elimination of the air compressor and lower frictional loss, is responsible for the excellent fuel economy.—*Power*, June 29, 1920.

NAVIGATION AND RADIO

THE RUSSELL-RANKEN STEERING RECORDER.—The question of good steering, in addition to being of vital importance to the safety of a vessel, also greatly affects economy of propulsion by the maintenance of a steady course, while there is also the question of economical use of power for the steering engine. A recent series of tests on a large modern steamship showed surprising results in regard to different helmsmen. It was found that the best helsmen made 85 movements of the steering wheel per hour, and the worst 565. A device, therefore, which records the steering operations, and thus enables investigation of them, has possibilities of great practical usefulness. Such a device is available in the Russell-Ranken steering recorder illustrated in figure, which records graphically, without need of subsequent plotting or calculation, every movement of the helm, at the same time registering the hour, the minute, half-minute and quarter-minute. It shows the amount of helm to port or starboard, the length of time taken to operate the rudder, and the length of time it remained in a stationary condition.

The recorder may be connected to either the controlling shaft of the steering engine or to the rudder-post, and, depending upon which of the plans is adopted, the position of the instrument may be either aft in some suitable position, or on the bridge.

The instrument is a combination of three main features, viz.:

1. A slide carrying the marking device, and attached either to the rudder-post or to the intermediate fore and aft shafting between the engine and steering gear.
2. A clock, having combined with it an automatic recording apparatus.
3. A clockwork mechanism operating the paper.

Each of these mechanisms operates free of the others. The paper is speeded at approximately one-half inch per minute; but as the paper is automatically stamped by a mechanism controlled by the clock, the approximate time of any recorded movement may be at once read off without taking the speed of the paper into account. A movement of one-half inch per minute of paper is calculated to give a clear diagram, that is, transverse lines made by the pen will not overrun one another, and they will be suffi-

RUSSELL-RANKEN STEERING RECORDER.

ciently far apart to give a clear indication of the length of time the rudder remained stationary. The paper may be ruled lengthwise with a black central line, and red lines to indicate differences of five degrees to port, and green lines five degrees to starboard; or if plain paper is used, the number of degrees may be at once determined by use of a transparent scale, laid off against one edge of the paper.

The instrument is contained in an air-tight case, arranged horizontally, the case being in plan 20 inches by 20 inches by 12 inches deep, with a receiver below to contain the record after it passes the friction rollers which draw the paper over from the "stock" roll.

The face plate carries, in addition to the face of the recording clock, a scale and pointer, which is a duplicate of that on the steering pedestal fitted on the bridge. Both the clock mechanisms are wound from the face plate, and all that is necessary in starting the machine is to wind the clocks, see the recording clock is set at the correct time, and set the recording pen regulator so that its position coincides with the pointer on the scale.

By thus having an exact record of every movement of the helm, a spirit of interest and competition should become general among the various quartermasters and helmsmen, erratic or careless steering would be brought to notice as well as good steering, and a higher state of proficiency reached.

Another advantage is the complete record available of the doings of the steering gear, information which, in collisions and other incidents in ship-handling, it is often very desirable to bring forward when legal or other proceedings are resorted to.—*The Shipbuilder.*

PITOT TUBE ADAPTED TO USE AS NAVIGATOR'S LOG.—The navigator log is a Swedish invention and is being placed on the American market by the American Navigator Log Corporation, Park Row Building. The device is based on the principle of the Pitot tube and is simple in operation. The business end of it protrudes vertically from the bottom of the vessel and consists of a hollow tube with two passages. Near the end of the tube are two holes, one facing the direction in which the ship is traveling, and the other opening on the side of the ship. A passage through which the water flows leads from each hole to the mechanism immediately inside the hull.

The hole facing towards the ships bows registers the water pressure produced by the speed of the vessel, while that on the side gauges the hydrostatic pressure, or that resulting from the draft of the ship. The pressures record themselves upon a membrane in an indicator located in the engine-room, which measures the difference between the speed and draft pressure of the vessel and thus determines her speed. From the engine-room indicator there is conveyed to a second indicator on the bridge by means of an electric current a registration of every knot traveled by the ship. The officer on duty is thus able to tell not only how fast his ship is traveling, but also the total number of knots the ship has traveled since the indicator was set.

The log is said to begin to act as soon as the vessel is set in motion and to indicate with the greatest precision both the speed of the vessel, as well as the distance traveled. It further begins to register at very low speed (1 to 1½ knots), and acts independently of all external conditions, such as changes of temperature, the draft of the vessel, the rolling and pitching of same, etc.

The apparatus is well protected and easy to instal. When once in place it requires little attention. Nor does it call for frequent adjustments, refilling, winding, etc. It is of small dimensions, weighing only 80 pounds. One of these logs has been installed on the United States Shipping Board steamer *Huron.*—*The Nautical Gazette,* June 19, 1920.

WIRELESS HALFWAY 'ROUND THE WORLD.—The Lafayette Radio Station, situated 11 miles southwest of Bordeaux, France, the most powerful radio station in the world, has just been completed by the United States Navy and turned over to the French Government.

The erection of a super high-powered radio station in Europe was the result of a decision made by a military committee called by the Navy Department, which met at New London, Conn., October 4, 1917, and constituted part of a general programme adopted for the improvement of transatlantic radio facilities. It was felt a substantial transatlantic radio service was needed in the event that enemy depredations might destroy or impair communications by cable.

After several preliminary discussions it was agreed that the French Government would furnish a suitable site in France, properly protected, and would erect and furnish buildings, foundations, a water supply and power facilities. The Navy Department agreed to design the plant supply and erect the towers and to install equipment in complete operating condition.

In view of the small size and inadequacy of the existing European stations (Eiffel Tower, Lyons, Nantes and Rome), it was realized that the new station would have to carry an immense volume of traffic in the event that the entire communication burden should be thrown on the radio service; so it was decided to design a plant larger than any in existence.

Signals from European stations were studied, and it was found that even a station as powerful as Nauen (which had been greatly enlarged by Germany during the war) would not be able to give proper service during periods of the day when fading and static combined to produce the most unfavorable conditions.

Alternator equipment for producing radio high frequency currents had not been satisfactorily developed in this country at the time the design of the plant was undertaken and the selection of apparatus narrowed down to the only type which had been demonstrated as entirely successful, namely, the Poulsen arc. The navy was well informed regarding transmitter types, and a contract was placed with a responsible concern for the radio equipment which was to be rated at an antenna current of 550 amperes with an antenna effective height of approximately 600 feet. This design involved an arc converter and power machinery of a capacity between 1000 and 1200 kilowatts. The apparatus was to be furnished in duplicate throughout to avoid any possibility of failure.

While these arrangements were being made the Bureau of Yards and Docks completed designs for an 820-foot three-legged self-supporting steel tower similar in type to the Eiffel Tower. The Eiffel Tower, however, weighs about 2700 tons while each Lafayette towers weighs only 550 tons.

In fact the Lafayette towers, eight in number, are the real engineering marvel of the plant. Their three legs rest on large circular concrete platforms which in turn rest upon a series of concrete "feet" placed upon planks sunk deeply into the ground. The sturdy towers are quite capable of carrying elevators and the French have already considered their installation.

Because of the difficulty of carrying on work over seaes by contract, it became necessary to organize a military detachment to erect the station, particularly as the French Government was desirous of carrying on all such work under a military establishment. Through the co-operation of the Bureau of Navigation, Navy Department, a special recruiting party was organized and a detachment containing nearly 600 steel workers, bridgemen, electricians, and all others required (cooks, yeomen, etc.), was sent to the selected site in the spring and summer of 1918, and began work under the supervision of the Bureau of Steam Engineering, Navy Department.

In order to cope with the transportation problem, special officers were stationed at Philadelphia and at Bordeaux to personally supervise shipments. The duplicate radio equipment parts were forwarded on separate vessels to avoid possible loss by submarining, and it is to the credit of the transport service that no material was lost.

Practically all the tower steel and radio equipment was on the station site in September, 1918, an incredibly short time after the inception of the project, together with a complete erection crew and camp. At this date, however, the French had not yet started on the radio buildings or power supply and were just commencing on the tower foundations. The detachment, therefore, had to erect a temporary power-transmission line and furnish a water and drainage system. The officer in charge urged more rapid progress on the part of the French authorities regarding their portion of the work, with the result that several towers were partly under way on the date of the armistice, although nothing could be done toward installing the radio

equipment. At this time the rainy season in western France commenced and all progress ceased.

The withdrawal of our military forces from Europe early in 1919 made it necessary to disband nearly the entire detachment, the members of which were returned to the United States. The skeleton of an organization was retained at the radio station, however, and an agreement was finally consummated with the French Government whereby the Republic of France contracted to purchase the Lafayette station on condition that the navy would complete it. Work again proceeded, therefore, in June, 1919, the tower erection being taken up by an American contractor, and the remaining work undertaken by the navy, utilizing labor from the New York Navy Yard and elsewhere.

The incoming power supply is 3-phase alternating current of 11,000 volts and 50 cycles frequency. The 1000 kilowatt, 1200-volt direct-current generators are driven by synchronous motors with direct-connected exciters for both motors and generators. Special 20-kilowatt direct-current motor-generator sets are provided to excite special field-winding on the arc converters, designed to enable accurate adjustments of the field flux density to be made.

These windings are arranged so as either to assist or to oppose the effect of the usual series windings, which also exist.

The antenna system is of an extent far exceeding that of any existing radio system. The eight 820-foot towers are arranged in two rows of four each. The rows are spaced 1320 feet apart, and the towers in each row are 1320 feet apart, making a plot approximately a mile long, a quarter of a mile wide, and containing 5,227,200 square feet.

The power house is located in the center at one end of the aisle formed by the two tower rows. Triatics stretching across this aisle between pairs of towers support the longitudinal antenna wires, which are of number three silicon bronze cable.

A special problem arose in connection with the insulation of this antenna because of the extremely high mechanical loads which the triatics are required to carry, but a special porcelain tubular insulator was eventually developed having a length of about ten feet with a mechanical ultimate strength of over 15 tons and an electrical flash-over voltage when dry of about 190,000 volts at a frequency of 50,000 cycles.

The largest station previously constructed by the navy is the one at Annapolis, Maryland, which can deliver a maximum output of 168,000 ampere-feet, whereas the Lafayette station should be capable of delivering 330,000 ampere-feet with more on overload. The maximum wave-length of the Lafayette station will be about 23,000 meters.

From these facts it is evident that the Lafayette station, and it is quite appropriately named, will be practically twice as powerful as any radio station now in existence. It will be capable of transmitting messages approximately 12,500 miles or halfway around the world.

France has a colony at Noumea, New Caledonia, which is just about halfway around the world from Bordeaux. Messages from Bordeaux will reach New Caledonia from both directions, which will probably develop some interesting scientific data.

The present plan is for the Lafayette station to transmit at the rate of 50 words per minute, or 72,000 words per day. Sending messages at such a high speed by hand continuously is out of the question, so the signalling will be done by a mechanical device through which a narrow tape is run bearing the dots and dashes previously perforated by a special kind of typewriter made expressly for the purpose. There are few radio receiving operators who can handle incoming messages at this speed for hours at a time, no matter how expert they are, and to meet this contingency, as well as to guard against errors, it is said that the French intend to equip their stations throughout the world with mechanical receiving apparatus that will make phonographic records of incoming messages. These records may afterwards be "played" over more slowly and transcribed.

Practically all of the great nations now have powerful transoceanic radio plants. Norway has, at Ullenhaug near Stavanger, a transmitting station using tape sending machines. There are ten 400-foot masts in pairs holding an antenna of 24 wires. The power is 300 kilowatts, and the normal sending wave is approximately 10,000 meters. This station sends to America, while its mate, at Naerland, 20 miles south, does the receiving, using the phonographic roll method. Its antenna is held by eight iron masts 300 feet in height.

The Lyons radio station, the largest French station previous to the construction of the Lafayette station, uses apparatus orginally intended for a plant in Indo-China. Eight towers, six of which are 590 feet high and two 787 feet high, carry an antenna in a sheet 2952 feet long by 492 feet wide. The wave-carrying capacity of Lyons is approximately 6210 miles on a power of 150 kilowatts. It is reported that Shanghai papers get their daily news from the Lyons station, and that messages from this station have been heard distinctly at Guam, in the Ladrone Islands, 7452 miles distant.

Back in 1913 there were 560,000 cablegrams handled between the United States and Japan. This number jumped to over 3,000,000 in 1917 and touched the 5,000,000 mark the following year. It is reported the Japanese are constructing a very powerful radio station in northern Japan for commercial use. At present their navy radio plant close to Funabashi is giving a few hours daily to transpacific radiograms most of which are sent to Hawaii for further relay to the United States. Funabashi is powerful enough, however, to work direct with San Francisco, when atmospheric conditions are favorable. The normal working wave of this big plant is about 7000 meters. The station compound takes up about four acres of ground. A triangular pillar 787 feet in height is in the center, and ranged in a circle around it at a radius of close to 360 feet are 16 secondary square pillars 196 feet high. The antenna wires radiate from the central tower to the secondary pillars like the ribs of a colossal umbrella.

In the United States the Naval Radio Station at Annapolis, Maryland, is probably the most powerful. Its four towers form a square and they are 620 feet in height. The radius of action is normally 6,500 miles under a power of 500 kilowatts.

Germany has two big radio stations, Nauen and Eilvese. Great Britain has a monster plant at Carnavon, Wales. Italy can radio to America from Coltano, and Spain has apparatus by no means tiny at Aranjuez which is worked through a distant control wire at Madrid. These facts and figures serve merely to give a general idea of the radio system of the world and to emphasize the magnitude of the Lafayette station.

Our army and navy will leave many monuments in France as a record of our participation in the World War. Among these monuments the Lafayette Radio Station will be one of the most striking and useful.—*The Scientific American,* June 26, 1920.

THE THERMOIONIC TUBE.—The thermoionic tube or valve has become an instrument of such wide utility that the lucid exposition of its principle, which Professor W. Eccles, D. Sc., of Finsbury Technical College, gave last April in two Royal Institution lectures on "The Thermoionic Tube as Detector, Amplifier and Generator of Electric Oscillations" will be welcome to our readers. Every substance, he explained, emits electrons when heated. The mechanism resembles that of ordinary evaporation; but the electrons carry electro-negative charges, whilst the evaporated molecules are uncharged. The phenomena are complex in gaseous atmospheres, but simple in high vacua. When we apply an electromotive force E. M. F. to two electrodes facing one another and heat the cathode, a stream of electrons will flow from the cathode to the anode, *i. e.,* in the opposite direction to the old conventional current (see Fig. 1 and also Fig. 2, on page 1359), the thermoionic current rising as we raise

the temperature in a steep curve (Fig. 3). A heated tungsten filament will hardly emit electrons below 2,000° C.; above 2000° the current increases rapidly, reaching at 2500° 200 times its value at 2000°. In the Fleming valve or diode the anode is a cylinder surrounding the tungsten filament of a lamp, and the diode is used as rectifier, the current travelling only in the direction mentioned. Dr. Eccles exemplified this by reversing the key in the battery circuit by hand, about five times per minute, when the galvanometer deflections were always to the right—never to the left. Since now the current is carried by the small electrons, practically devoid of inertia, the valve can likewise rectify currents of 10,000,000 reversals, per minute. But the curve of Fig. 3, which turns level, and Fig. 2, will help to show that temperature and electromotive force applied have to be adapted to one another. With a low E. M. F. of 55 volts, *e. g.*, the current will cease to increase when we raise the temperature above a certain value, of 2300°; we pass then to the flat maximum of the curve. It is true that we can liberate more electrons by heating the filament to a higher temperature. But these electrons are not emitted at high speeds; they gather near the cathode and, being all electro-negative, repel one another, so that their further liberation is stopped. This "space charge," due to the neighboring electrons, will not shift a particle midway between the electrodes, but will tend to drive an electron near the cathode back into the cathode, and drive another one near the anode upward towards it (Fig. 2), unless we overcome this space charge by applying a stronger E. M. F. The more positive we make the upper electrode, the more the zero position (between the electrodes) will be shifted towards the cathode. Starting with a battery current of 150 volts, Dr. Eccles could reduce the volts to 52, without diminishing the galvanometer deflection by more than 2 divisions, from 25 to 23. That showed that the current was on the level portion of the curve (Fig. 3) in the saturated condition, in which all the electrons emitted are utilized. A valve used in this condition served as a limiting device safeguarding the apparatus to which it was coupled; the current would not rise above the maximum corresponding to the level portion of the curve. To make the valve more sensitive to fluctuations in the E. M. F., we should try to work on the rising straight portion of the curve, a result which in this case, the lecturer remarked, would be obtained by raising the temperature of the filament.

Value of the straight curve was, however, better seen in the case of the triode, which contained a third electrode, the "grid," between the anode and cathode. The grid may be a wire bent to the shape of a grid, or a spiral, surrounding the filament. The diagram, Fig. 4, shows the parts of the triode [within a circle] and the rather complicated connections. The upper electrode, the anode, is joined to the main battery, and this circuit is known as the anode or plate circuit; the grid is indicated by the dotted line; the cathode or filament circuit comprises the small battery heating the filament. When the grid and anode are directly connected the triode becomes a diode. The advantage of the grid is that it enables us to alter the space charge. When the grid is made positive, it eliminates the repulsive force between the electrons, facilitates their emission and increases the current; when made negative the grid reduces the emission and the current is decreased, the point being that one grid volt is able to cancel x plate volts, the x increasing as the grid is approached to the cathode.

With the aid of a galvanometer in the external circuit, Dr. Eccles demonstrated that the addition (or cutting out) of one dry cell to the grid circuit had the same effect as the addition of 6 cells to the plate circuit. The triode, he said, was used for the amplification of the current input on the constant current system, the constant voltage system, or (more generally) by combinations of the two systems. By coupling 20 triodes in cascade, each giving an amplification of 10, the total magnification obtained would be 10^{20}. The regulation could be effected by transformers as well as by resistances, the coils acting largely as choking coils. Since

the grid required little current to feed it, the triode was very convenient to get over the difficulties of bad contacts. Dr. Eccles exemplified this by an experiment ascribed to Edison. A contact is made by approaching a lighted cigar or a match to a strip of ebonite which bends under the influence of heat; the effect was much more striking when afforded another illustration of the power of the triode. In this device (due to the present Lord Rayleigh) a small radium tube and a small metal-foil electroscope are enclosed in an evacuated bulb; the radiations charge the electroscope, the expanding leaves of which touch contacts in the bulb; when one of these contacts was joined to an amplifier, the discharge became audible.

Since the expenditure of small energy in the grid circuit liberates large energy in the plate circuit, the triode can also be utilized in controlling devices. A master pendulum inducing minute current oscillations in the grid circuit can sustain the oscillations of another pendulum of the same period through the aid of an electromagnet in the plate circuit. Fig. 5 illustrates a novel alternating-current motor of Dr. Eccles, based upon this principle. There are two electromagnets, I in the grid, II in the plate circuit; between them rotates an ebonite wheel set with contacts or teeth. When the motor is turned and a tooth approaches I, the current induced is magnified in II, enabling II to pull the next tooth round; the effect is repeated when a tooth recedes.

The small motor exhibited was not self-starting, but when brought up to speed by hand it keeps its speed, and Dr. Eccles has found it very convenient for producing currents, of variable, but constant frequency for testing purposes; the alternating currents may be branched off from terminals in the plate circuit or from a transformer coil. The motor is probably the first of its kind working without slip rings or commutator; the sparking of the commutator would seriously interfere with any delicate testing of high-frequency apparatus.

In another device Dr. Eccles had replaced the motor wheel by a tuning fork, electromagnet I being above the one prong, II below the other. But any oscillating device may be coupled with a triode to produce amplified electric oscillations, and Fig. 4 already mentioned exemplifies the connections of a coil for this purpose. The ends of the coil are joined to the grid and the plate circuits, the middle of the coil being connected to the filament. The oscillations act upon the grid and are themselves acted upon by the fluctuating plate current. There was no outward sign that Dr. Eccles' coil was really oscillating. To prove it, he approached a similar coil circuit, containing a crystal detector (serving as rectifier for the induced currents) and a galvanometer.

Of more practical interest was the other demonstration by the "heterodyne or beat method." When two oscillating circuits are tuned to nearly the same frequency, 500,000 oscillations per second the one, 500,100 oscillations the other, the second circuit comprising a rectifier and a telephone, the telephone will give the difference (or beat) note of $d = 100$ oscillations per second. It is essential that the currents should be rectified as well as amplified, and that is secured by the arrangement illustrated in Fig. 6. The additional devices shown are (apart from the telephone) a small condenser and a high resistance in shunt to it, both in the grid circuit. Electrons can accumulate in the condenser only when the grid is positive; that accumulation, however, turns the grid negative and would diminish the plate current, if the resistance mentioned, the "grid leak," did not allow the negative charge to escape so that the plate current can rise again. The frequency of the oscillations now can be varied by altering the capacity. When the frequency difference d amounts to thousands of oscillations per second, no sound will be heard; as we increase the capacity in the one circuit, the d will decrease, and the sound will become audible; when we come down to $d = 30$, the sound will be inaudible again. The audibility will depend upon the listener and his age and upon the kind of telephone, and the listener can adjust the pitch to his own liking. If we

increase the capacity beyond the perfect tuning adjustment where $d=0$, the sound intensity will become stronger again, and the position intermediate between the positions of maximum intensity will mark the capacity for perfect tuning.

TRIODE OSCILLATION SET

Fig.1.

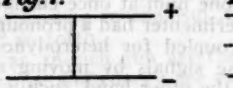


Fig.2.

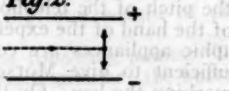
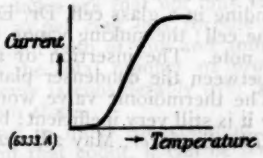


Fig.3.



OSCILLATION WITH CUMULATIVE RECTIFICATION FOR BEAT RECEPTION.

Fig.4.

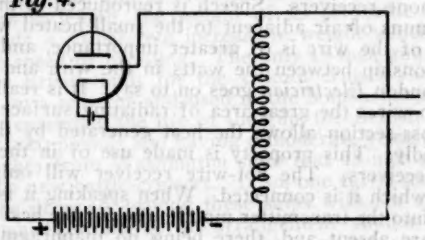


Fig.5.

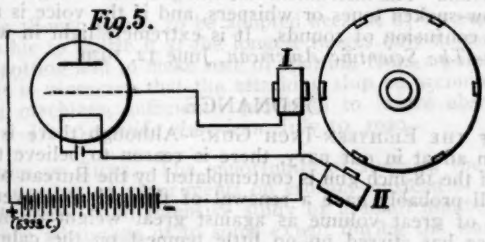
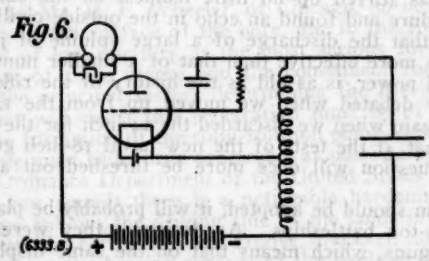


Fig.6.



The extraordinary sensitiveness of such oscillating coils, especially if of small dimensions, to intentional or accidental slight changes in the capacity or inductance was demonstrated by Dr. Eccles, and its various utilisations were explained. When a piece of apparatus or simply a piece of wire, particularly if forming a closed ring, was brought near one of the oscillators the pitch of the telephone hum at once changed; even the mere movement of the hand of the experimenter had a pronounced effect. When radiotelegraphic appliances are coupled for heterodyne receiving, it may hence be sufficient to give Morse signals by moving a small wire loop instead of working the key. On the other hand, such a pair of oscillators can serve as a delicate induction balance. A small loop of copper wire had a stronger effect than a loop of iron wire. Taking a condenser made up of two vertical zinc plates standing in a glass cell, Dr. Eccles held an open bottle containing ether over the cell; the sinking vapor (heavier than air) affected the capacity and the note. The insertion of a piece of ebonite or paper, or of a gas flame between the condenser plates would produce similar or opposite effects. The thermoionic valve works with electrons. From the energy point of view it is still very inefficient; but it does wonderful things by simple means.—*The Engineer*, May 28, 1920.

HOT-WIRE TELEPHONES.—Thermophones are actuated by heat instead of electro-magnetism, and hence their characteristics are different from those of the usual telephone receivers. Speech is reproduced in the receiver by the motion of columns of air adjacent to the small heated wires. In this case the diameter of the wire is of greater importance, and it is well to consider the relationship between the watts in the wire and the diameter of the wire, the London *Electrician* goes on to say. It is really understood that with very thin wires the great area of radiating surface as compared with the small cross-section allows the heat generated by the current to dissipate very rapidly. This property is made use of in the construction of thermophone receivers. The hot-wire receiver will only respond to the transmitter to which it is connected. When speaking it is necessary to speak close to and into the transmitter mouthpiece for the best transmission. Inductive effects are absent and, there being no diaphragm, there is no inherent distortion. The instrument has the great advantage of responding perfectly to low-spoken tones or whispers, and if the voice is raised there is no clash or confusion of sounds. It is extremely light in weight, from 0.25 to 0.5 oz.—*The Scientific American*, June 12, 1920.

ORDNANCE

THE ERA OF THE EIGHTEEN-INCH GUN.—Although there is not as yet an 18-inch gun afloat in our navy, there is reason to believe that already the adoption of the 18-inch gun is contemplated by the Bureau of Ordnance. If so, we shall probably have a renewal of the old controversy between the advocates of great volume as against great weight of fire, such as more than once has stirred up no little tempest on the calm waters of bureaucratic procedure and found an echo in the outside civilian world.

The contention that the discharge of a large volume of projectiles of moderate weight is more effective than that of a smaller number of much greater weight and power, is as old as the history of the rifled gun. The question was hotly debated when we moved up from the 12-inch to the 14-inch gun, and again when we discarded the 14-inch for the 16-inch gun; and it is certain that, if the tests of the new naval 18-inch gun should be satisfactory, the question will once more be threshed out along the old lines.

If the 18-inch gun should be adopted, it will probably be placed on some of our new 43,000-ton battleships. As designed, they were to carry 12 50-caliber 16-inch guns, which means that on the same displacement and with the same speed, fuel supplies and general accommodations, they will be

able to mount only eight 18-inch guns, particularly if the new pieces are to be of 50-caliber length. Many people will be surprised that a reduction of 50 per cent in the number of guns should be necessary when the caliber is increased only about 12 per cent, but this is because the weights of guns and projectiles increase approximately as the cube of the diameter. This applies not merely to the rifle itself, but it affects also the weight of the mount and the loading mechanism, the total weight of projectiles in the magazines, and so forth.

In favor of an 18-inch gun are the following points: The gun is more accurate; its range and energy are much greater; the bursting charge also is greatly increased, and therefore the destructive effect, when penetration of armor has been effected, is far greater.

The disadvantages are that not only is the number of shells delivered in a single salvo 30 per cent less for the eight-gun battery, but because of the greater weight both of gun and ammunition, the rate of fire is slowed down, so that the total number of projectiles delivered in a given time against the enemy is considerably over 30 per cent less than that delivered from the 12-gun ship.

Now, bearing in mind the common saying aboard ship that it is the shells which hit that count, it can be seen that there is over a 50 per cent better chance of landing on the enemy with a 12-gun *Indiana* than there would be with an eight-gun *Massachusetts*. The 16-inch shell weighs 2100 pounds, and if we aim at the highest velocities and make our 18-inch gun 50 calibers in length, the weight of its projectile will probably be about 3000 pounds, a 50 per cent increase in weight which must necessarily slow down the speed of handling. The only 18-inch gun afloat is the big fellow which the British built for the 32-knot cruiser *Furious*, but subsequently mounted on a monitor and used in the bombardment of Zeebrugge. With a view to extending the life of the gun, the British used a heavy projectile weighing 3600 pounds and having a moderate velocity.

Despatches from Washington state that 18-inch guns are to be used on two of the new battle-cruisers. If so, one turret and a pair of guns would have to be dropped, leaving these ships with six 18-inch guns in two-gun turrets, which would be an arrangement similar to that on the battle-cruisers *Repulse* and *Renown*, which mount six 15-inch guns in three turrets.

If the 18-inch gun is to be adopted because of its superior range, it will be possible to utilize it at the longest ranges only in combination with airplane spotting and to make sure of spotting from a point above the enemy's ships, it is necessary that the attacking ship be accompanied by a fleet of fighting machines, sufficiently powerful to insure absolute superiority in the air.—*The Scientific American*, July 10, 1920.

EROSION OF GUNS.—The opportunity of studying the salient features of a large number of experiments on erosion—instead of following the more usual practice of an intensive study of a small number of experiments—was taken advantage of to some extent during the war, but, according to a paper by Mr. H. E. Wheeler, of Chicago, no new facts were developed. Cracking of the surface of the bore, due to the formation of a hard layer of metal of low ductility, is the most serious form of erosion. The enlargement of these cracks and the consequent roughening of the bore is one of the principal factors determining the life of guns of large caliber. Steel that will resist this penetration must be of such composition as to resist the formation of the solid-solution phase—chromium, etc.—and at the same time must be as little penetrable as possible by the gases. Tests made by the Ordnance Department of the United States Army showed that even after a few rounds there is a noticeable hardening of the surface. The formation follows the driving side of the lands preferentially, and eventually affects the entire land and groove, and even the powder chamber. The formation on the bearing surface of the lands extends much further down

the bore than on any other part of the circumference. Owing to its low ductility, it at once develops a network of fine hair cracks which make a characteristic pattern, the largest cracks being parallel with or perpendicular to the axis of the bore.—*The Engineer*, June 25, 1920.

THE CAPITAL SHIP: A TRIPLE VERDICT.—The methodical way in which the United States and Japan continue to add dreadnought after dreadnought to their respective fleets indicates more convincingly than words could do the confidence which these two Powers retain in the big battleship. On March 3 of this year the *Maryland* was launched at Newport News, Va., and a few days ago the *Mutsu* was put afloat at Yokosuka for the Japanese Navy. The two ships are strikingly similar, as the following details show:

	U. S. S. Maryland	H. I. J. M. S. Mutsu
Length	624 ft. (overall)	661 ft.
Beam	97 ft. 3 in.	95 ft.
Draft, mean	30 ft. 6 in.	30 ft.
Displacement, normal.	32,600 tons	33,800 tons
Speed	21 knots	23½ knots
Main armament	8 16-in. 45-cal.	8 16-in. 45 cal.

The Japanese ship is thus 1200 tons heavier, and has an advantage in speed of 2½ knots. Probably, however, she has less protection than the *Maryland*, which carries 16-inch armor on the belt and 9-inch to 18-inch on the turrets. The *Mutsu's* secondary battery will consist of 5.5 mm. or 6-inch Q. F., as compared with 5-inch guns in the American vessels, while the former is likely to mount a heavier torpedo armament. Generally speaking, in modern ships the size of the beam gives the measure of anti-torpedo protection, in which feature the *Maryland* apparently is superior to her contemporary. But to those who attach value to a good turn of speed the *Mutsu* will appeal as the better ship.

Powerful as these two ships are, they are far from representing the apex of foreign battleship development. For the time being Great Britain is out of the running, and, as it were, living on her capital. But sooner or later—failing the establishment of the League of Nations on a solid basis and its corollary of a limitation of armaments—she will have to resume the burden of naval shipbuilding, and by that time dimensions and cost will probably have risen to a gigantic figure. It is as well that this probability should be recognized now; otherwise there is sure to be an outcry when Parliament, a few years hence, is asked to sanction the building of 50,000-ton battleships, costing anything from eight to ten millions sterling. The monster vessels on which the United States and Japan are working cannot be dismissed as "mythical armadas." Six American ships, constituting the latest class, have been laid down in the past eight months, and two of their number (*South Dakota* and *Indiana*) were seven per cent complete on March 1. This type will displace 43,200 tons normally, 45,000 tons at full load, and mount a battery of 12 16-inch 50-caliber guns. Larger and more expensive still will be the six American battle-cruisers, the first of which, *Saratoga*, was laid down a few weeks ago. Not to be outdone, the Japanese are beginning work this summer on two new battleships, *Amagi* and *Akagi*, reported to displace 53,400 tons at normal draft; and, if precedent counts for anything, the United States will soon produce something bigger still. It is therefore quite misleading to talk of the *Hood* as the "last word" in naval design, as some papers persist in doing. Alike in size, speed, fighting power, and cost that ship will be surpassed by the *U. S. S. Saratoga;* and whereas the *Hood* is the sole representative of her type, the *Saratoga* boasts no less than five sisters.

Those who are not conversant with the technicalities of the subject may well feel puzzled at this wholesale production of ships which certain eminent naval officers in this country have pronounced to be so much scrap iron. But there is really no mystery about it. After a patient and ex-

haustive examination of all the data provided by the war, the shrewdest experts in America and Japan have come to the conclusion that an effective substitute for the capital ship has yet to be devised—in other words, that the large, well-armored, heavily-gunned battleship is not seriously menaced by attack from above or below, and can only be fought on equal terms by a ship of her own type. No one will accuse either America or Japan of ultra-conservatism; both are thoroughly progressive nations, and are always among the first to seize and exploit a promising innovation in the realm of naval science. Consequently, their action in continuing to lay down huge battleships designed to move and fight upon the surface of the sea may carry conviction even in circles where the British Admiralty's recent defence of the capital ship was attributed to the traditional conservatism of Whitehall.

I am assured on good authority that the Japanese naval constructors within the past three years have spent large sums of money on experiments to determine the best method of enabling heavy ships to resist underwater explosion; further, that the result has been to confirm their view that a ship may be made virtually invulnerable to such attack by devoting a not unreasonable percentage of displacement to protective devices, which also assist in minimizing the effects of gunfire. The same conclusion, based either on practical experiment or war data, had previously been reached by the British Admiralty and the United States Navy Department. This means that the technical directors of the three leading naval powers of the world have awarded a certificate of the highest efficiency to the capital ship, and it will take something more than theory to upset this triple verdict.

Apparently there is still an acute divergence of opinion regarding the value of speed. The prevailing view on this side is that very high speed does not balance a deficiency in armament or protection; and, in conformity with this view, the original plans of the *Hood* were modified on the basis of reduced speed and increased protection. In America, on the other hand, they are still prepared to make heavy sacrifices in order to obtain superiority in speed. According to latest report, the battle-cruiser *Saratoga*, which is two knots faster than the *Hood*, will have a belt only five inches thick, compared with 12-inch armor in the British ship. Should this be correct, it will incline naval opinion in this country to assess the actual fighting value of the *Saratoga* at a figure considerably lower than the rank she occupies on paper. The lesson of Jutland, where several ships superior in speed and armament were destroyed by opponents inferior in every quality but that of protection, has sunk deep into naval minds on this side, and armor, once held in very light esteem, is now regarded as second only to gun power.—*The Naval and Military Record*, June 9, 1920.

MISCELLANEOUS

CHARACTER BUILDING IN THE ARMY.—There was no finer result of the World War than the liberation of the spirit of service caused by the call to arms. The war presented a single objective for the creative energies of the entire nation, and in striving to attain this objective the people became a united nation as never before. The national spirit was expressed in a democratic and effective army and navy which maintained American ideals abroad with success and dignity. All of the diversified national forces and capabilities were organized to accomplish a single end, and the war was won.

The people of the United States, having experienced the exhilaration that comes from service in a righteous cause, are now searching for new ways and means of continuing this service in time of peace. They have learned that personal interest and ambition are not so inspiring or absorbing as national interest and service. They have learned to cooperate with one another in new ways and desire to continue to cooperate for the public good. The problem of preserving the lasting lessons of war experience is one of the most pressing problems now before the country.

As far as the army is concerned, this problem may be analyzed by noting the changes that were wrought in army activities by experience. For before the war the army was a numerically small and frequently unrecognized factor of national strength. It always was a symbol of national defense and an embodiment of the spirit of national service; yet it was a tight little army—a thing little observed and apart from the national life except when disorders arose. There was little intercourse and less mutual understanding between soldier and civilian. In fact, many civilians were prone to regard the soldier as an anachronism, as a relic of a bygone age.

With the outbreak of the war, these untoward conditions were suddenly changed. The soldier was dragged from his military isolation and placed in the center of the stage. The nation went enthusiastically to work to create an army that would adequately express the national spirit and power. In the process old misunderstandings have been cleared up. The civilian has caught the spirit of service and discipline of the soldier, while the soldier has grasped the value of the humane and liberalizing elements of civil life.

Inspired by the belief in this opportunity for national service, the army has definitely instituted a system of human development based upon its long practice as a military training institution and its experience during the emergency, and since the armistice, in education, vocational training, citizenship instruction, healthy recreation and development of a real sense of moral values. This system is conducted according to the high standards and ideals of national service which the army throughout its history has possessed. The system broadens army activities. It intensifies, animates and modernizes military training to agree with the conception derived from the war of the man as a combined soldier and citizen.

In this work the military training is being conducted in such a manner that adequate means for national defense will be always available. The officers are being trained as the leaders of men, and the soldiers are trained as intelligent and capable national defenders who have at all times every incentive and opportunity to become themselves leaders if they can develop the qualities of leadership. The education now given in the army effectively guarantees that soldiers, whose pre-army education has been defective, cannot remain illiterates, and offers to all members of the army a real opportunity to acquire occupational skill which will enable them to leave the service qualified to be self-supporting citizens. Education for illiterates and non-English speaking soldiers is made compulsory and is conducted by officer, soldier and civilian teachers and according to methods devised by expert civilian educational counselors. Occupational training is given under instruction methods developed by expert vocational trainers who have been employed by the army, many of them on leave from the leading educational institutions of the country. Teachers of occupational training are obtained by the employment in the army of well-qualified civilian teachers and by the use of officers and soldiers as instructors who have, by their pre-war experience or their experience during the war, learned the practical details of the occupations in which they instruct. Army education also provides for the army the large number of technical specialists that modern war demands.

The question of leisure time of officers and soldiers also receives careful consideration. The army is a very closely knit community. Officers and soldiers not only work together but live together. The army realizes its obligation to provide means whereby officers and soldiers may be given a moral equivalent for the home environment which civilians possess. It has therefore established clubs and recreation centers in its various posts, camps and stations. It equips libraries, builds theaters, provides professional entertainment for these theaters, and encourages the development of amateur dramatics. Experience during the World War has shown that soldier players can produce dramatic work of high character. Music is

encouraged, and the formation of vocal and instrumental musical organizations is fostered. Athletics, which has always been an important army activity, is given further stimulus, and athletic equipment and instruction is adequately provided. Exchange or cooperative stores run by the army for the benefit of the army have been maintained for a great number of years. These, conducted according to modern business methods, will continue to serve officers and soldiers, their profits being used for promoting recreational activities.

The World War emphasized the fact that strength of character in the nation and strength of character in the soldiers of the nation are the final decisive elements upon which victory rests. Every activity of the soldier's life has a definite effect in strengthening or weakening character. Hence, military training and duties, general and vocational education, recreation and all functions of army life are coordinate with the definite purpose of developing self-control, self-respect, realization of the obligation of service and moral thoughtfulness in all officers and soldiers. This ideal of service is emphasized in every activity of the army. Recreation is conceived in the spirit of fair play, athletics emphasize fair play, clean sport, and teach officers and soldiers not only to be successful winners but to be good losers and to combat the ever present temptation to make "anything to win" the standard.

Religion as an essential to life is recognized, and provision is made for the religious needs of the army personnel. It is believed that each citizen of our nation is free to establish his relationship to God according to the dictates of his conscience, and each officer and soldier is given an opportunity to follow the faith of his choice. Respect and encouragement for religion are held as important obligations of an officer's position of leadersip.

The army believes that the soundest morality and the highest character are those developed by the individual himself in response to his own incentives. Therefore soldiers have been urged to form clubs or associations with the explicit purpose of encouraging initiative, self-reliance, "team-play," a broadminded tolerance, an intelligent patriotism, and the desire to serve one's group, one's neighborhood and one's country. These clubs are looked to for the development of a fine spirit of service on the part of their members. In these clubs the soldier learns the practical details of community life and its consequent community obligations. Upon the soldier as a club member rests a portion of the responsibility for the success of the club. Upon the citizen who returns to civil life from the army will rest his share of the responsibility for his community.

This broad conception which the United States Army now has of its full mission to the country and the diverse activities it has entered upon make it most vitally necessary that the army, if it is to succeed in this mission, have the greatest amount of cooperation from the communities near the posts, camps and stations of the army, from all of the finest and best organizations of our social life and from the common enthusiasm and spirit of the whole nation. The army has set up specific machinery to insure the fullest cooperation between its officers and soldiers and the communities in which officers and soldiers are located. It is urging communities and the people of the country to consider the army as a vital and natural part of the social organism of the nation and not to consider the armed forces as separate and distinct from the rest of American life, but as inevitably and permanently interwoven with the whole social fabric.

In its purpose to express essentially American ideals and to develop American men according to this program the army feels that it may properly ask and will undoubtedly receive the support of all good Americans and of all organized bodies of American life that stand for the progressive betterment of our country.—*The Infantry Journal*, July, 1920.

THE SCIENTIFIC VALUE OF SPEED CONTESTS.—In all great sporting contests in which high speed is the deciding factor, many people, in whom the critical faculty is developed at the expense of others equally valuable, make themselves audible in protest against the sacrifice of strength and durability which is necessary in producing a first-class racing machine, be it airplane, yacht or automobile. "What is the sense," they ask, "of building a contraption which, if it should be so fortunate as to hold together for one supreme effort, has no further use in the broad field of sport and pleasure?"

An off-hand answer to this question would be to remind these gentlemen that sport is sport; that the craving for high speed is a protest against the natural inertia of things; and that, if a man does not possess in his veins the good, red blood to which speed as an element of sport appeals, it is more his misfortune than his fault, and he is to be pitied rather than blamed. But, as a matter of fact, the ardent pursuit of speed in racing machines has reacted most favorably upon the mechanical arts. The race course is a very practical, man-sized kind of laboratory, where the products of the labor of the designer at his drafting board are given a gruelling test, during which the one weak link in the chain, if there be such, is certain to be disclosed. The great value of the construction and competition of racing machines is that we gain in knowledge of the dynamic as compared with the static stresses. Static stresses can be determined with great accuracy, and the testing machine gives us equal accuracy in determining the strength of materials; but in driving an automobile at a racing speed, and even more in smashing one's way with an over-sparred and lightly-constructed yacht against short, snappy seas, there are dynamic stresses developed, the exact strength and effect of which no man can foretell through the medium of theoretical calculations.

Moreover, racing has greatly stimulated the quest for materials that are light in proportion to their weight; and there can be no doubt that for the many wonderful alloys which are available in the constructive arts to-day we are beholden, not a little, to the craze for speed, with its demand for a maximum of strength with a minimum of weight. To think of the racing car is to think of aluminum, vanadium steel, and last, the wonderful molybdenum steel; and a restrospective survey of the America's Cup races calls to mind the hollow steel boom of *Valkyrie III*, the Tobin bronze and aluminum hull of *Defender*, the light but strong hollow wooden spars culminating in the great hollow mast of *Shamrock IV*, and the tapered, hollow aviation spar which forms the topmast of *Vanitie*, to say nothing of the aluminum gaff carried by *Resolute*. A test case as to the industrial value of yacht construction is the three-ply mahogany shell of *Shamrock's* hull, which proved so tough and strong and water-tight that its designer built Government ships, during the war, of a thousand tons capacity, on this principle.—*The Scientific American*, July 10, 1920.

SIGNALLING BY INVISIBLE RAYS.—Remarkable feats in signalling by radiations outside the visible spectrum, both infra-red and ultraviolet, were accomplished during the war and, it must be added, still more strange things were attempted. It was found possible, for instance, to detect the presence of a living warm body, lying outside a trench in the dark, by the heat rays coming from it. But it was hardly possible, though repeatedly suggested, to discover the approach of a steamer or submarine, in a fog, by the thermal radiations from the smoke stack, since water vapor is opaque to infra-red radiations. The experiments on secret signalling were not initiated during the war. Books on the subject were published in 1913, by Ruhmer in Germany and by Miessner in the United States. Since selenium was the most sensitive photoelectric substance then known, the first war experiments were conducted with selenium. But a search for photoelectric substances was made, notably by Case and by Coblentz and others in the Bureau of Standards, and several sulphides were found promising. Some

crystals of molybdenite, molybdenum sulphide, in particular proved up to 200 times as sensitive to heat rays as a gold leaf radiometer, an instrument of the bolometer type. Gold and platinum, blackened on the one side with soot, absorb all the incident radiations and are hence not suitable for the selective absorption of heat rays. The man in front of a trench is difficult to detect when he wears a heavy coat and covers his face, and a boat is not easily picked out from a shore background.

In the radiophonic signalling of the Bureau of Standards, so far as described by W. W. Coblentz last year before the American Physical Society (the full paper is not yet available), a pulsating electric current is produced by interposing a rotating sector-disc between the source of radiation and the receiver. The receiver consists of a crystal of molybdenite, a battery of dry cells, of about 50 volts, connected directly to the input terminals of a three-stage amplifier and a telephone; a concave mirror, silver on glass, of 16 cm. diameter and 50 cm. focal length, concentrates the radiations on the receiver. In the simpler field apparatus, the crystal mirror, disc and battery of six cells are mounted on a camera tripod.

In the experiments conducted at Washington, the transmitting and receiving stations were situated on the roofs of two houses, separated by three miles of houses and dusty streets. When the radiation source was a 300-candle tungsten lamp mounted in a searchlight reflector, the transmission was very good at the full distance mentioned. With an automobile headlight of 20 candles in a metal reflector the signals were not always audible; sighted on a street lamp (80 candles) the apparatus still responded at a distance of half a mile, but the interposition of a glass screen and the exclusive use of the infra-red rays made the signals uncertain.

The full moon proved an excellent source of radiation; the intensity of the moonlight is estimated at 3×10^{-7} gramme-calorie per second. Since the sector disc used cut off about half of the light and reduced the time of exposure to about 1/500 second, the sector wheel radiophone could not be very efficient, and attempts were made to change the pitch in the telephone note, apparently on the heterodyne reception principle. It was observed that the high resistance then wanted in series with the crystal weakened the sounds, but when several crystal-receivers were connected in series to make up the resistance, better results were obtained. Considerable success was realized with potassium-hydride photoelectric cells of the gas-ionic type; but particulars were not communicated.

Professor R. W. Wood, of Baltimore, who came over to France, devised several other ingenious devices which he himself built up out of very primitive apparatus. When he demonstrated their use, so far as desirable, before the Physical Society of London, he particularly spoke of a small lamp arranged in telescope fashion so as to give a very narrow, almost invisible, beam of light. To secure further secrecy he used a red light filter for day service and an ultraviolet filter for night service, the observer being correspondingly provided with a red screen (which shut out the daylight but transmitted the red beam) or with a fluorescent screen.

Another device was Professor Wood's lamp for naval convoy, radiating in all directions. This was a mercury lamp provided with a glass chimney permeable only to rays of λ 3660; these are invisible, but they make the retina and lens of the eye fluoresce so that an observer at close quarters sees a haze, the so-called "lavender fog," filling his field of view; the rays could only be picked up by a receiver comprising a fluorescent screen. This instrument had a range of four miles (that previously described had a range of six miles) that by its aid ships were kept together without showing any light.

We need hardly say that similar devices were worked out in this country. It is to be hoped that the researches are proceeding, though they may remain for the present locked up in official archives. There is, however, little need for secret signalling in normal times. But astronomers, meteorologists and other scientists might find such instruments useful, and the thermo-

ionic valve, which forms part of some of these devices, has sufficiently established the startling technical possibilities of observations apparently of purely theoretical interest.—*Engineering*, June 11, 1920.

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NOTES ON INTERNATIONAL AFFAIRS

FROM JUNE 10 TO JULY 10

PREPARED BY

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WORK OF THE SPA CONFERENCE

PRELIMINARY MEETING AT BOULOGNE.—At a preliminary conference of Allied premiers held at Boulogne on June 22 a note was approved and despatched to Germany concerning the reduction of her war materials and limitation of her army to 100,000 men. It was also decided that Greece should be authorized to undertake military operations against the Turkish Nationalist forces in Asia Minor, and that trade parleys with Russia should continue on the condition that there should be no question of recognizing the Soviet Government.

BRUSSELS CONFERENCE FIXES INDEMNITY.—Meeting at Brussels on July 2, as a preliminary to the Spa Conference, Allied diplomats agreed definitely that the total sum to be demanded of Germany should be 6,000,000,000 pounds sterling (or 30,000,000,000 dollars at normal exchange), to be paid at the rate of 150,000,000 pounds a year for the first five years, and 250,000,000 pounds a year thereafter, with accrued interest.

The difficult problem of settling upon the division of the German reparation money remained undecided. According to the plan previously approved, France would receive 52 per cent, England 22 per cent, Belgium 8 per cent, and Serbia 5 per cent, leaving 13 per cent for Italy, Portugal and Japan. Italy, however, presented claims for 20 per cent which she suggested should be apportioned without depriving Belgium of any part of her share. It was finally decided that the division might properly be left until an agreement was reached with Germany as to what she should pay.

GERMAN APPEAL.—A 50,000 word memorandum presented by Germany made no reference to the amount Germany would be able to pay, but requested the following concessions, as essential to Germany's economic recovery:

(a) Equality of Germany on "the most favored nation" basis in trade with her former enemies.

(b) No military reprisal measures without warning.

(c) Restoration to the German Government of control over all German waterways and means of transportation.

(d) Right to collect import duties in gold.

(e) Reduction of cost of occupation forces, below the cost of 3,000,000,000 marks for last year.

(f) Allotment of merchant tonnage up to 13,000,000 tons annually.

(g) Proceeds of German property liquidated abroad.

Against these claims, it was pointed out that the Allies might urge in the first place the fact that Germany is the only one of the warring European powers that did not contract a heavy foreign debt in the course of the war.

RESULTS OF THE SPA CONFERENCE.—The meeting of German and Allied diplomats at Spa, in Belgium, opened on July 5, the program for discussion including disarmament, prosecution of war criminals, fulfilment of coal agreements, the Danzig question, and reparation.

Discussion of the reduction of the German army brought out the fact that of over 6,000,000 German rifles at the close of the war 2,000,000 remained unaccounted for, and that 1,000,000 men were still under arms. Germany pleaded that the government could not maintain peace, in view of the disturbed condition of the country, without an armed force of at least 200,000. Under Allied pressure, however, a protocol was signed on July 9, by which Germany agreed to complete the required reduction in six months' time.

In the matter of prosecution of war criminals, Germany requested further evidence and more time.

In general, the decision to include German diplomats at the Spa and later conferences represented a victory for British policy over that of France, and a virtual recognition of the fact that the terms of the Versailles Treaty are still a matter for debate. At the first contact with German diplomats the Allied powers maintained a united front.

LEAGUE OF NATIONS

REPUBLICAN PLANK IN LEAGUE OF NATIONS.—The Republican Party stands for agreement among the nations to preserve the peace of the world. We believe that such an international association must be based upon international justice and must provide methods which shall maintain the rule of public right by development of law and the decision of impartial courts and which shall secure instant and general international conference whenever peace shall be threatened by political action, so that the nations pledged to do and insist upon what is just and fair may exercise their influence and power for the prevention of war.

We believe that all this can be done without the compromise of national independence, without depriving the people of the United States in advance of the right to determine for themselves what is just and fair when the occasion arises and without involving them as participants and not as peacemakers in a multitude of quarrels, the merits of which they are unable to judge.

The covenant signed by the President at Paris failed signally to accomplish this purpose and contained stipulations not only intolerable for an independent people, but certain to produce the injustice, hostility and controversy among nations which it proposed to prevent.

That covenant repudiated to a degree wholly unnecessary and unjustifiable the time-honored policy in favor of peace declared by Washington and Jefferson and Monroe and pursued by all American administrators for more than a century, and it ignored the universal sentiments of America for generations past in favor of international law and arbitration, and it rested the hope of the future upon mere expediency and negotiation.

The unfortunate insistence of the President upon having his own way without any change and without any regard to the opinion of the majority of the Senate, which shares with him in the treaty-making power, and the President's demand that the treaty should be ratified without any modification, created a situation in which Senators were required to vote upon their consciences and their oaths according to their judgment upon the treaty as it was presented or submit to the commands of a dictator in a matter where the authority under the Constitution was theirs and not his.

The Senators performed their duty faithfully. We approve their conduct and honor, their courage and fidelity and we pledge the coming Republican Administration to such agreement with the other nations of the world as shall meet the full duty of America to civilization and humanity in accordance with American ideals and without surrendering the right of the American people to exercise its judgment and its power in favor of justice and peace.

DEMOCRATIC LEAGUE PLANK.—San Francisco, July 1.—The vital section of the Democratic League of Nations plank as adopted by the Committee on Resolutions with the final phrase added by the amendment of Senator Walsh of Massachusetts reads:

"We indorse the President's view of our international obligations and commend Democrats in Congress for voting against reservations designed to cut to pieces the vital provisions of the Versailles treaty and against resolutions for a separate peace which would disgrace the nation. We advocate prompt ratification of the treaty without reservations which would impair its essential integrity, but we do not oppose reservations which would make more clear or specific our obligations to the associated nations."

LEAGUE DEFERS ACTION ON PERSIAN APPEAL.—On June 16, the League Council in session in London notified Persia that action would be deferred regarding Russian occupation of the Persian Port of Enzeli on the Caspian Sea, pending the result of direct negotiations between Persia and the Soviets. In a note to Persia announced on June 15, the Soviet Foreign Minister assured Persia that the Soviet Government had "no designs against Persian independence," and that Russian troops would be withdrawn from Enzeli as soon as "Persian independence is guaranteed and she is no longer under foreign influence."

REPATRIATION OF PRISONERS.—In a report to the League Council at London, Dr. Nansen stated that there were still about 250,000 former prisoners of war in Russia, and as many more in Germany and neighboring countries. Exchange was going on through Esthonia and Finland, and he hoped to send home 60,000 Russians and an equal number of Germans before winter.

FINANCIAL CONFERENCE ON JULY 23.—In a letter to the Supreme Council, M. Leon Bourgeois, acting for the Council of the League of Nations, stated that the League financial conference would be held at Brussels on July 23. M. Bourgeois urged the necessity of determining definitely at Spa the obligations of Germany and the general economic situation of the former central powers. He also pointed out the necessity of inviting German delegates to the Brussels meeting.

WORK ON WORLD COURT.—The first session of the commission for organizing a permanent court of international justice was held at The

Hague on June 16. It was decided that the court should be permanently located at The Hague. It was also agreed that in at least five types of cases, involving interpretation of treaties, infractions of international law, or interpretation of court decisions, resort to the court should be compulsory. On July 5 it was decided that the Root-Phillimore plan for the selection of judges should be used. This plan provides adequate representation for small states.

TURKEY AND THE NEAR EAST

MAP OF ASIA MINOR SHOWING THE MAIN RESULTS OF THE TURKISH PEACE TREATY. THE SOUTHWESTERN BOUNDARY OF ARMENIA IS GIVEN HERE TENTATIVELY ALONG THE GENERAL LINES WHICH PRESIDENT WILSON IS EXPECTED TO FOLLOW AS ARBITRATOR. ALL THAT REMAINS OF TURKEY IN EUROPE IS THE LITTLE CORNER FROM CONSTANTINOPLE TO CHATALJA.—*July N. Y. Times Current History.*

GREEK OFFENSIVE AGAINST TURK NATIONALISTS.—During the month of June Premier Venizelos of Greece secured the approval of the Supreme Council for a Greek campaign in Western Asia Minor against the Turkish insurgents under Kermal Pasha. With the cooperation of British naval forces, the campaign began about June 21, from both ends of the railroad from Smyrna to Panderma in the Sea of Marmora. It was ended July 2, with the junction of the two forces and complete occupation of the railway. On July 8, it was reported that the city of Brussa, 57 miles southeast of Constantinople, was held by Greek forces. Mudania, on the Sea of Marmora, was shelled and occupied by British naval forces on July 5.

TREATY NEGOTIATIONS POSTPONED.—On June 26, the Turkish peace delegation presented a memorandum explaining their objections to the Peace Treaty in its present form, and on July 1, the Turkish Grand Vizier, head of

the delegation, returned to Constantinople. The Supreme Council decided later at Spa that the treaty should be revised in details by experts to accord with the legitimate objections of the Turks.

POWERS OF STRAITS COMMISSION.—Washington, June 16 (Associated Press).—Limited internationalization of the Port of Constantinople and its inclusion within the "zone of the straits" is provided for in the provisional terms of the Turkish treaty. This is disclosed by an official summary received here to-day of the jurisdiction provided for in the Inter-allied Commission of Control.

With its own flag, budget and separate organization, the commission will have authority over a territory considerably greater than some of the smaller nations of Europe. Made almost sovereign in itself, the commission is to be practically independent of the League of Nations, as stipulation is expressly made that should it find liberty of passage of the straits interfered with, it shall take such measures as may be deemed necessary to preserve the freedom of the straits.

The zone includes not only the Bosporus, Sea of Marmora and the Dardanelles, but also three miles off shore from the mouth of the Dardanelles and the Bosporus and the Aegean Islands of Samothrace, Imbros, Lemnos, Tenedos and Lesbos. A land zone also is provided, extending from ten to seventeen miles northwest of the Sea of Marmora and eight to twenty-eight miles southeast of it.

Its northwestern limit is partly common with the new Greek frontier, 52 miles west of the Bosporus, on the Black Sea; its eastern limit is 40 miles east of the mouth of the Bosporus, and its southwestern limit is partly common with the district of Smyrna, 55 miles southeast of the entrance to the Dardanelles. The zone also includes an area on the western side of the Gallipoli Peninsula which Turkey cedes to England, France and Italy for war memorials and cemeteries.

Regulations laid down for enforcement by the Inter-Allied Commission provide that:

No belligerent warships may remain within ports of the zone longer than twenty-four hours or take on food, stores or recruits.

The Dardanelles, Sea of Marmora and the Bosporus are to be open in peace and war to every vessel of commerce and war.

The straits are not subject to blockade.

No belligerent right to be exercised and no act of hostility committed within the zone, except upon special authorization of the League of Nations.

All military works and fortifications to be demolished, and no roads or railroads to be constructed within the zone for movement of mobile batteries.

Greece and Turkey are prohibited from constructing any new wireless stations within the zone; all present ones to be taken over by the Allied powers.

These regulations are to be enforced chiefly with naval forces and a force of special police recruited within the zone and commanded by foreign officers, as well as such military and naval air forces and guard-ships of their own as Great Britain, France and Italy may deem necessary.

In addition to the general laws pertaining to the administration of the straits, the commission is further charged with execution of any works considered necessary for the improvement of the channels and the approaches to harbors, the lighting and buoying of channels, control of pilotage, towage, anchorage and all matters relating to wrecks, salvage and lighterage.

Maintenance of the ports of Constantinople and Haida Pasha as ports of international concern, where the citizens, goods and flags of all countries

belonging to the League of Nations shall enjoy complete freedom, is also placed within the control of the commission, which shall provide at the two ports free zones for the erection and use of warehouses.—*N. Y. Times*, June 17.

RUSSIA AND POLAND

POLES RETREAT BEFORE RED OFFENSIVE.—During the latter part of June and the month of July Soviet forces in great strength developed a vigorous offensive along the whole Polish battle line, concentrating their efforts on the northern front. The fall of the fortress of Rovno, on the Volhynia front east of Lutsk, was announced on July 7.

Falling back before the Russian advance, Poland issued a call for all able-bodied men and concentrated government administration in a military triumvirate. Defending Poland's war with the Soviets, the Polish Minister to the United States issued on July 9 a statement in part as follows:

The present difficult situation of the Polish Army is widely regarded here as the natural result of what is considered a short-sighted move in attacking Russia. It has been pointed out again and again that Poland, in the Ukraine offensive, was attacking national Russia rather than the Bolsheviki, thus placing the Soviet Government in the rôle of national defender against a foreign foe. It has been foreseen here for some time that the support thus brought to the Red leaders of Russia for the needs of the moment would be sufficient to crush the Polish efforts in that direction. Poland, it is pointed out, has united both Bolsheviki and loyal Russians against her.

The statement issued by Count Lubowurski says:

"The war which Poland is carrying on is not one of conquest, but exclusively one of defense. The Bolsheviki invaded Poland at the moment of its liberation, and we were forced to take up arms in our defense. We have no intention of going to Moscow, nor interfering in Russian affairs. We have not even passed the frontiers of Poland of 1772. We have not even asked for the territory which belonged to us before 1772. We have only wanted to protect those regions peopled by Polish subjects, to liberate them from the oppression of Bolshevism and to create around us friendly nations who will stand with us against the barbarism of the East.

"The propositions of peace of the Soviet Russia were not sincere. We knew they were preparing a great attack, and we wanted to avert it by a drive on their points of concentration, but the young Ukrainian Republic was not able to organize in such a short time an army sufficiently large to withstand the avalanche of Bolshevism.

WRANGEL ADVANCES IN SOUTH RUSSIA.—In the Crimea, the Anti-Soviet forces under General Wrangel, reorganized from General Denikin's defeated army, again advanced northward, meeting slight opposition on account of the Soviet concentration against Poland.

The British naval occupation forces at the Black Sea port of Batum have blown up the fortifications, with the view of evacuating the city before July 18 and leaving it an open port under control of the Georgian Republic.

TRADE PARLEYS TO CONTINUE.—At the Boulogne Conference on June 22 it was decided that trade negotiations with Russia in London should continue, on the understanding that there should be no question of recognizing the Soviets. This decision represented a compromise of the divergent policies of Great Britain and France, Great Britain desiring to secure

various political aims by holding out the prospect of trade, France opposing any action which might enable the Soviet Government to establish itself and repudiate the debts of the old régime.

On June 30 M. Krassin, the Russian trade delegate, left London for Moscow, ostensibly to consult his home government. This was regarded at the time as a rupture of negotiations, though later rumors appeared to the effect that he would be succeeded at London by M. Tchitcherin, Soviet Foreign Minister.

UNITED STATES REMOVES TRADE RESTRICTIONS.—On July 7 the United States Department of State issued the following announcement of the removal of restrictions on Russian trade:

"The restrictions which have heretofore stood in the way of trade and communication with Soviet Russia were to-day removed by action of the Department of State. Such of these restrictions, however, as pertain to the shipment of materials susceptible of immediate use for war purposes will, for the present at least, be maintained.

"Political recognition, resent or future, of any Russian authority exercising or claiming to exercise governmental functions, is neither granted nor implied by this action. It should be emphasized, moreover, that individuals or corporations availing themselves of the present opportunity to trade with Russia will do so on their own responsibility and at their own risk. The assistance which the United States can normally extend to its citizens who engage in trade or travel in some foreign country whose Government is recognized by the United States cannot be looked for in the present case, since there is no official or representative Russian authority with which this government can maintain those relations usually subsisting between nations.

"The action which the United States is now taking in nowise constitutes a recognition of the validity of industrial or commercial commissions granted by any existing Russian authority. American citizens availing themselves of the present relaxation of restrictions are warned against the risks incident to the acceptance of commodities or other values, the title to which may later be brought into question."

GERMANY

CABINET FROM MIDDLE PARTIES.—After difficulties and delays, a ministry was finally organized in Germany during the last week of June, under the chancellorship of Konstantin Fehrenbach, former President of the Reichstag. The Cabinet has the support of the "Middle" parties—Centrists, Nationalists, and Peoples Parties—with the "benevolent neutrality" of the majority Socialists. According to figures of June 15, the composition of the Reichstag is as follows:

Parties	Deputies	Popular vote
Majority Socialists	110	5,531,137
Independent Socialists	80	4,809,862
Centrists	67	3,500,800
German Nationalists	65	3,638,851
German People's Party	61	3,456,131
Democrats	45	2,152,509
Christian Federalists	21	1,254,963
Communists (Spartacists)	2	438,190
Bavarian Peasants' Party	4	.....
Guelphists	5	318,104

It will be seen that out of a total of over 25,000,000 votes, only about 5,000,000 were cast for candidates of the radical parties, the Independent Socialists and Communists.

The Fehrenbach Cabinet is made up as follows, Ministers Fehrenbach, Simons, and Wirth constituting the German delegation at Spa:

Chancellor—Konstantin Fehrenbach,
Minister of Foreign Affairs—Dr. Walter Simons.
Minister of Finance—Dr. Wirth.
Minister of the Interior—Herr Koch.
Minister of Defense—Herr Gessler.
Minister of Transport—General Groener.
Minister of Food—Andres Hermes.
Minister of Posts and Telegraphs—Johann Giesberts.
Minister of Economics—Herr Scholz.
Minister of the Treasury—Herr von Raumer.

—*N. Y. Times.*

AUSTRIA AND HUNGARY

BOYCOTT OF HUNGARY.—The International Federation of Trades Unions from its headquarters at Amsterdam issued on June 3 a summons for a boycott of Hungary in retaliation for the alleged persecution of labor by the Hungarian "White Terror." The boycott called for a complete stoppage of traffic and communication with Hungary, to be executed by the workers of Austria, Czechoslovakia, and Jugoslavia, and to begin on June 20.

Following the putting into effect of the boycott Hungary endeavored to retaliate by refusing to export coal and food supplies to Austria.

AUSTRIAN CABINET DIFFICULTIES.—The Renner Cabinet in Austria resigned on June 11. During the remainder of June President Seitz held conferences with leaders of the Socialist and Social Christian parties, in a vain effort to set up a new ministry. Both parties coveted the post of Minister of the Interior, because of its value in the impending elections.

ITALY

ALBANIA RISES AGAINST ITALY.—After the conclusion of the World War, Italian forces remained in occupation of Albania, pending settlement of the Adriatic question in which the disposition of Albania was involved. In opposition to the Supreme Council's plan of January 20, 1920, which virtually divided Albania between Italy, Serbia, and Greece, President Wilson came out strongly for Albanian independence. Encouraged by the American atitude, the Albanians organized a provisional government, held a national assembly at Lushnja, January 28, 1920, and planned armed conflict with the Italian forces.

In June Italy began withdrawing troops to the Albanian seaports, and of these she finally retained only Avlona, under the protection of warships. On June 29 came reports of the capture of Avlona by the Albanians, but this was later denied.

GIOLITTI RETURNS TO POWER.—In June the Nitti Government fell for the third and last time. Former Premier Giolitti, suspected of pro-German leanings prior to Italy's entry into the war, came back into power. The Giolitti Cabinet, as announced on June 15, consists of prominent leaders of the Liberal, Catholic, and Radical parties. Admiral Sechi, one of the foremost naval experts, holds the naval portfolio, and Count Sforza that of foreign affairs.

In the Italian Chamber of Deputies the Socialists hold 156 seats, Catholics 101, Liberals 161, the remainder of the 518 seats being occupied by representatives of various small factions. Giolitti's power lies in his continued control of 60 of the 69 provincial prefects who supervise Italian elections, these being hold-overs from his long period of rule before the war.

IRELAND

RIOTS IN LONDONDERRY.—During riots in Londonderry, June 18, 19, and later, between Sinn Feiners and Unionists, five were killed, ten severely wounded, and many others injured. Incendiarism and food stoppage added to the seriousness of the situation in the city, military forces having difficulty in reestablishing order between the hostile factions.

SINN FEIN ASSUMES CONTROL.—According to reports from Ireland, the newly organized Sinn Fein courts are rapidly superseding the crown tribunals, their decrees receiving popular sanction. Sinn Feiners are also enforcing regulations regarding the liquor traffic. Transportation in Ireland is in serious difficulties owing to the refusal of railroad workers to handle trains carrying government troops.

MEXICO

VILLA OFFERS TERMS.—Early in July a representative of the Obregon Government secured from the insurgent leader Francisco Villa an armistice agreement until July 15 and a statement of the conditions upon which he would cease his activities. These include his appointment as a general in the Mexican army, with a force of men to maintain order in certain districts of Chihuahua. Failing agreement to his terms, Villa threatens renewal of brigandage on a large scale.

HIGH COMMISSIONER TO UNITED STATES.—Senor Fernando Calderon arrived in Washington on June 28 as High Commissioner from Mexico with the rank of ambassador. Through his efforts it is believed that friendly and satisfactory relations may be established between the two countries, and the way paved for recognition. Congressional elections in Mexico are set for August 21, and Presidential elections for September 5.

OIL COMMISSION.—It is stated that the Mexican Secretary of Commerce and Labor, General Trevino, will appoint a commission of prominent Mexicans to study the oil question, and will invite the participation of

American representatives. Representatives of American oil interests now in Mexico are not favored for this purpose, because committed to a policy of American intervention.

FAR EAST

JAPAN OCCUPIES SAGHALIEN PROVINCE.—Pending reparation for the killing of Japanese troops and civilians at Nikolaievsk, Japan has taken military possession of the upper part of the island of Saghalien and the opposite coast on the main land. The government on July 3 announced its intention to withdraw its forces from other parts of Siberia, especially from the interior.

Washington, July 6.—Information received here is that the limits of the new Siberian Republic, which already has been recognized by the Soviet Government, probably will include the three Continental provinces of Trans-Bakailia, Amur and the maritime province which includes Vladivostok. These limits, however, remain to be defined by a boundary treaty.

Relations between the Japanese Government and the new Republic, it is said, will depend entirely upon the action of the Siberians themselves and the decision on their part to assume or repudiate responsibility for the massacre at Nikolaievsk.

Advices received here to-day from Japan say the anti-Bolshevist population has welcomed the Japanese forces which have taken military possession of the upper part of Saghalien and the opposite coast on the mainland as a result of the massacre. On the other hand, an active propaganda against the Japanese is being carried on by the sympathizers with the Soviet Government.

It is stated in well informed quarters here that the Japanese troops will make no hostile move against the new Republic unless attacked. At last advice exchanges were in progress between the military leaders on both sides with the design of arranging temporary boundary lines to separate the two nationalities and prevent hostile collisions.

FAR EASTERN REPUBLIC.—At the head of the recently organized Far Eastern Republic, with its seat at Verkni—Udinsk in Trans-Baikalia, is a former Chicago lawyer, A. S. Tobelson, now known as Krasnotchekoff. Tobelson came to Chicago from Russia in 1910, studied law, practiced in labor cases, and in June of 1917 went to Vladivostok, it is said at the invitation of his friend Leon Trotzsky. Here he became head of the Far Eastern Soviet.

ANGLO-JAPANESE TREATY RENEWAL.—Tokio news despatches of early July announced the intention of British and Japanese diplomats to revise the Anglo-Japanese Alliance in conformity with the League of Nations covenant, and to have it ready for signature before the Prince of Wales visits Japan next spring.

Baron Okuma is reported as advocating an alliance in the following terms:

"Without the alliance," he asked, "what about the future of India, and that of China and that of Siberia? The fact is indisputable that for all the success the British Government has attained so far in the administration of India, there are many malcontents in that country. The facts should be particularly noted that the majority of the inhabitants of Northern India are Mohammedans, who are as militaristic as they are religious. Since the

fall of the Turkish Empire there has been increasing unrest among them. To make the situation worse, the Bolsheviki are now very active on the borders of Turkestan and Afghanistan.

"At such a critical period as this nothing could have a worse influence on them than an impression that the Anglo-Japanese alliance is no more and that the Jaapnese would not interfere whatever might happen in India.

"The same theory may be applied to Japan as regards China and Siberia.

"Because of the Monroe Doctrine, the United States may be unable actually to participate in the alliance to be concluded between Great Britain and Japan; but if such participation should be made possible or should be desired by the American people, America would surely be welcomed into the group so as to form a triple alliance and thus maintain the peace of the Orient with greater efficiency."—*N. Y. Times,* July 2.

FOREIGNERS THREATENED AT PEKING.—On July 10 Generals Wu Pei Fui and Tsao Kun were reported to be advancing upon Peking along the Peking-Hankow railroad and threatening bombardment of the city, in spite of the warning of foreign diplomats against such an attack. The advance of the Chinese generals is against the dictatorship assumed by the Chinese leader Tuan Chi Jui.

The International forces at Peking number about 1400, the largest contingent consisting of American marines. About 3300 troops are available at Tien-tsin.

REVIEW OF BOOKS
ON
SUBJECTS OF PROFESSIONAL INTEREST

"The Maintenance of Peace." By S. C. Vestal, Lieutenant Colonel, Coast Artillery Corps, U. S. Army. (Published by G. P. Putnam Sons, New York.)

The secondary title of the book, "The Foundations of Domestic and International Peace as Deduced from the Study of the History of Nations," if for "Foundations" we substitute "Principles," more nearly indicates the scope of the work. The first few chapters are devoted to a discussion of the principles involved in the maintenance of domestic peace, and to showing how these principles have operated in Latin-America and in the United States. The remaining chapters are taken up with the major subject of International Peace. The ways of checking or controlling the tendency to conflict between nations are shown to be by world federation; by single nation domination; or by mutual guarantees of territorial integrity and independence, that is, treaties of alliance for maintaining the balance of power. All of these are fully discussed.

A Large part of the book is devoted to the history of ancient and modern wars, and the effect on the Balance of Power. The author is convinced that the maintenance of the Balance of Power is the only way by which the tyranny of a single nation may be avoided, and that the end of wars will come only by the efficient and immediate application of this principle, and that permanent international peace will exist only when the aggressor nation is sure to encounter overwhelming force, as would an aggressor state of the United States.

Arbitration as a panacea for war is fully discussed, and it is very clearly brought out that the problems of nations are of two general classes—political and legal. Legal problems may well be referred to an International Court of Arbitration, but political problems, which are by far the most numerous and vital, can only be settled by the people themselves, either by the ballot or by the bullet. In international politics, material strength, not morals, decides political questions, and the great problem of a world federation is to find some way by which international political questions may be settled by the numerical strength of the voters.

The book shows extensive study and thought on the part of the author, and his statements of facts taken from the history of the nations of the world, and his deductions of lessons to be drawn therefrom are clear, concise and entirely logical. The author concludes that universal disarmament is impracticable, as for domestic tranquillity some preparedness for

war is essential, and even if there were only one nation in the world the problem of domestic peace would still exist. No government can continue to exist unless it has the force to carry out its laws, and there is for every nation an irreducible minimum of preparedness that must be accepted. Universal disarmament would mean universal weakness for each subscribing nation as regards its own domestic force. Domestic peace can be guaranteed only by force in the hands of the majority. Disarmament makes civil war inevitable. International peace depends upon the known readiness of the nations of the world to aid each other in case of attack. The author shows how this end can be obtained.

In view of the recent general discussion of the principles of the League of Nations and the vital nature of the question of the advisability of the United States joining the League, this book should prove of special interest. It is well worth the reading and the careful thought of all students of governments and history, and should be particularly instructive to those in the military or naval service.

W. G. D.

"Hot Bulb Oil Engines and Suitable Vessels." By Walter Pollock, M. I. N. A., M. I. Mar. E., M. I. Mech. E., M. I. M. $10.00. (Published by D. Van Nostrand Company.)

The objects of this book, as stated in Chapter I, are: "(1) To popularize the engine, to explain what it has done and what it is capable of doing; (2) to enable those interested to appreciate the advantages and disadvantages of the various designs; (3) to facilitate the study and add to the general knowledge of this form of prime mover and its application to various types."

The author presents comparisons between the hot bulb oil engine (commonly and, according to the author, erroneously known as the Semi-Diesel) and all other accepted methods of propulsion for vessels of small and medium tonnage. A chapter on the different makes of hot bulb engines describes, without showing all detailed particulars, the characteristic features of some thirty-six commercial engines of this type, suitable for marine propulsion. The volume includes: A wealth of information, valuable to owner and operator, on design, parts, materials, fuels and lubricant, vessels for which suited and how placed therein, power, speed and consumption data; a chapter on operation and upkeep; a discussion of various methods of operating the auxiliaries on board a vessel propelled by this type of engine; and a very complete set of illustrations.

Descriptions of the engine plants in various types of ships include many classes of vessels from lifeboats to oceangoing ships, among which the motor-propelled reinforced concrete ship and the aerial-propelled surface vessel are of particular interest. The author presents an excellent argument for motor-propelled vessels in tropical waters.

This book should be highly instructive and useful to ship owners and operators, and of considerable interest to naval officers.

R. S. H.

"American Guns in War with Germany." By Edward S. Farrow. Price $2.50 net. (Published by E. P. Dutton & Co.)

The author is well known to the army as a writer of military works, including a military encyclopedia and has presented in readable form the gigantic problems met by the Ordnance Department, U. S. Army, in the production of arms and munitions for the American Forces. To anyone desiring to have at hand in a handy form the statistics of ordnance production the book will prove of value. It is a popular record of one of the remarkable war achievements of this country in the field of sudden expansion where the finest and most accurate machine work was required. Guns of all calibers, small arms, ammunition of all sorts, equipment such as limbers, caissons and tractors, sighting and fire control equipment of the most accurate sort, bombs, grenades, projectors, periscopes, and tanks, in fact the whole field of old and new devices for offensive warfare, are treated in most readable manner, and the result is well worth reading.

H. F.

"Diesel Engine Design." By H. F. P. Purday, B. Sc., A. S. G. I. Price $7.50. (Published by D. Van Nostrand Company, New York.)

This book written primarily for designers and draughtsmen will prove of interest to Diesel engine users and students.

Briefly, subjects taken up are Principles, Thermodynamics, Exhaust Suction and Scavenge, Similitude, Crank-shafts, Fly Wheels, Framework, Cylinders and Covers, Running Gear, Fuel Oil-Air-Exhaust-Compressed Air System, and Valve Gear.

One of the many interesting points brought out by the author is that the type of Internal Combustion Engine called Semi-Diesel is misnamed.

Two reasons are given for breakdowns of Diesel engines in marine work: (1) Steam engine plans are too closely followed; (2) designers assume a Diesel engine afloat radically differs from one ashore which is not borne out in actual practice.

The author states that indicator cards are even more important in Diesel engines than in steam engines.

The subject is clearly presented with numerous excellent sketches and references for details are given at the end of each chapter.

H. J. S.

"Fifty Years in the Royal Navy." By Admiral Sir Percy Scott. (Published by George H. Doran Company, New York.)

Admiral Sir Percy Scott, author of "Fifty Years in the Royal Navy," is well known to American naval officers. His brilliant career, and particularly the part he has taken in the development of gunnery, assures this book the welcome and close attention it deserves.

These memoirs include a narrative of personal experience afloat and ashore. Scott entered the navy at the age of eleven and a half years, saw duty suppressing slave trade in the Indian Ocean, fought in the Ashantee War, and, while still a junior officer, made a cruise around the world. As

a lieutenant he made a reputation in mounting and handling naval guns in the Egyptian campaign. At a considerably later period the heavy ordnance landed from the ship he commanded in South Africa took an essential part in gaining the decision of the war of the Transvaal. From there he sailed to China; and Captain Scott's naval guns were again called into active service, this time during the Boxer Rebellion. Finally, in the World War he was assigned somewhat mixed duty in connection with naval gunnery and the defence of London.

All this makes good reading, interspersed as it is with entertaining anecdote and personal experience. But it is the more professional side of the work which gives it an important place in the naval book-shelf. This side points a lesson in preparedness.

In his preface Admiral Scott states: "This book has been written in vain if it does not carry conviction that our naval administration is based on wrong principles." The author then proceeds in vigorous and unmistakable terms to reveal, as he sees them, the faults in the British naval system and their consequences.

Amongst other things the history of "Director Firing" is told to illustrate damage done by ultra-conservatism, defective organization, and Admiralty mis-management. An idea of this can be gathered from the following passages.

(In 1905 Captain John Jellicoe was made Director of Ordnance, and Captain Scott Inspector of Target Practice.)

"During our time in office we not only managed to introduce many reforms in naval gunnery, but tried hard to introduce "director firing." Unfortunately the Director of Naval Ordnance was not a member of the Board of Admiralty, and consequently carried no weight as regards naval gunnery, and this very necessary method of firing was not generally adopted until seven years afterwards, when war proved that the guns in our ships were of no use without it, a fact which throws a very heavy responsibility on the Board of Admiralty, which boycotted its introduction in former years."

(In 1907 Scott was ordered to command the Second Cruiser Squadron of the Channel Fleet, and he continued to occupy himself with progress in gunnery.)

"My attention was devoted to fitting my Flagship, H. M. S. *Good Hope*, with director firing, so that if she had to fight a German there would be a chance of her remaining on the top, instead of going to the bottom. . . . . This operation was difficult, as I could get no assistance from the Admiralty, and was forced to beg, borrow, or steal all the necessary material. . . . . I succeeded so well that the *Good Hope* became like the *Scylla* and *Terrible* in other years, top ship of the navy. . . . . But when I left the squadron on February 15, 1909, the routine I had instituted, and the 'director firing' I had installed, were put on the scrap heap, and the old method reinstalled. . . . . That is one way we had in the navy—a determination to fight against any change, however desirable."

As a sequel to the obstruction and delay encountered in introducing director firing Scott refers to the British disaster off Coronel which occurred in the first months of the great war seven years later:

"On November 1, 1914, my old ship, the *Good Hope*, in company with the *Monmouth, Glasgow*, and *Otranto* engaged the German cruisers *Scharnhorst, Gneisennau, Leipsig*, and *Dresden*, in the Pacific. After a short action the *Good Hope* and *Monmouth* were both sunk by German superior shooting. These ships were caught in bad weather, and as neither of them was fitted with any efficient system of firing their guns in such weather, they were, as predicted in my letter to the Admiralty of December 10, 1911, annihilated without doing any appreciable damage to the enemy.

"These two ships were sacrificed because the Admiralty would not fit them with efficient means of firing their guns in a sea-way. Had the system with which I had fitted the *Good Hope* been completed and retained in her, I daresay she might have seen further service and saved the gallant Cradock and his men on this occasion."

To clinch his argument Scott then tells of an official inspection visit paid by him to the Grand Fleet in November, 1914. The condition of things was not found satisfactory, and of this he writes:

"I had a conference with the First Lord (Mr. Winston Churchill) and the First Sea Lord (Lord Fisher), and pointed out to them the serious state of affairs, and how badly we should fare if the German Fleet came out. They realized the position and approved of practically all of the ships being fitted with director firing; and further, they agreed that I could arrange it without being held up by the ordinary Admiralty red tape. Consequently the fitting of the ships went on rapidly, and had the 'push' been maintained, our whole fleet would have been equipped by the end of 1915.

"In May, 1915, unfortunately for the nation, Lord Fisher left the Admiralty and all the 'push' ceased. I no longer had any influence; the authorities went back to their apathetic way of doing things; time, even in war-fare, was not considered of any importance by them. . . .

"At the Battle of Jutland, fought on May 31, 1916, the commander-in-chief had only six ships of his fleet completely fitted with director firing—that is, main as well as secondary armament; he had several ships with their primary armament not fitted; he had not a single cruiser in the fleet fitted for director firing; he had no Zeppelins as eyes for his fleet; his guns were outranged by those of the Germans. He had to use projectiles inferior to those used by the Germans; and in firing at night he was utterly outclassed by the enemy.

"One would have thought that, although their Lordships paid no attention to my warning in 1911, the moment the war was known to be inevitable, they would have bestirred themselves and ordered all the material necessary to put the fleet in a state of gunnery efficiency.

"And before I leave this subject of the unpreparedness of the Grand Fleet in some respects for war, I must revert to the criticism of Lord Jellicoe for not pursuing the German Navy after the battle of Jutland and fighting them on the night of May 31–June 1. Lord Jellicoe had a very good reason for not doing so. The British Fleet was not properly equipped

for fighting an action at night. The German Fleet was. Consequently, to fight them at night would only have been to court disaster. Lord Jellicoe's business was to preserve the Grand Fleet, the main defence of the Empire, as well as of the Allied cause—not to risk its existence. I have been asked why the Grand Fleet was not so well prepared to fight a night action as the German Navy. My answer is, 'Ask the Admiralty.'"

This is a serious charge against the Admiralty and many will question whether or not all responsibility rests there. It may be that the Admiralty only expressed a conservatism prevailing throughout the service and a general naval system which resisted change and progress. It may also be added that the author himself showed intolerance of modification to his suggested schemes and methods.

"Admiral Scott emphasizes the importance of concentrating effort on preparing the navy for war, and points out the danger of unwisely diverting peace time activities into other channels.

"Training naval officers and men as housemaids is not good for war; *Brains* are required. But however faulty our training in peace may have been, it did not effect the character of the British naval officer and seaman. Whether in a ship, submarine, balloon, aeroplane, motor car, tank, or as a soldier, the men who bore an anchor on their caps, and others who wore a sou'wester fought with a bravery not surpassed by any men in the world. Of the many thousand who went to the bottom of the ocean, a large number might have been alive now if in peace-time our legislators had attended to the war-preparedness of ships instead of chiefly to the housemaiding of them. I once heard a statement that "the blunders of our politicians and legislators are paid for with the blood of our soldiers and sailors." How terribly the war has demonstrated the truth of this statement!"

In the closing chapter the author gives sensational opinions on submarines which are by no means concurred in by the concensus of naval opinion. On the subject of gunnery, however, Scott speaks with authority. As gunnery officer, as captain, and as admiral, his ship headed the navy list in target competition. Results show his diligence and enthusiastic interest in the development of team-work and skill. The experience of war has proved his wisdom on the subject of director firing.

These are considerations which will cause naval officers and naval administrators to read carefully "Fifty Years in the Royal Navy."

C. C. G.